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CHES/NAVFAC-FPO-7819ES/NAVFAC-FPO-8241

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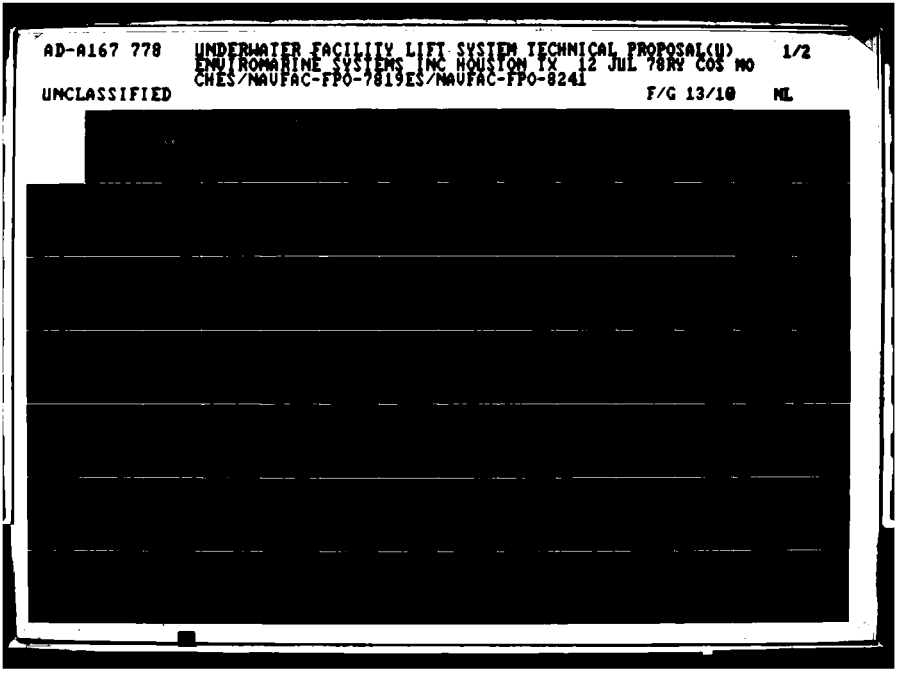

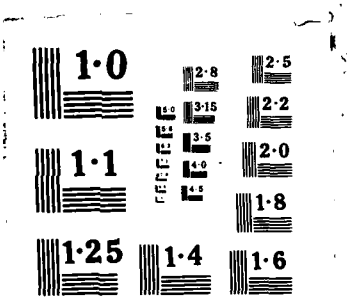
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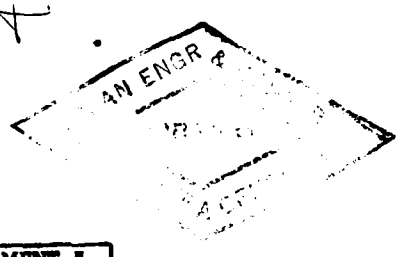
DEEP
SUBMERGENCE
INSTRUMENTATION
by

ENVIROMARINE SYSTEMS, INC.

UNDERWATER FACILITY LIFT SYSTEM

TECHNICAL PROPOSAL

ENVIROMARINE SYSTEMS, INC.



Submitted to NAVAL FACILITIES ENGINEERING COMMAND

in response to RFTP 78-CO-255

July 12, 1978

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Enviromarine Systems, Inc., in response to RFTP-78-CO-255, is pleased to submit to CHESDIVNAVFACENGCOM a proposal to provide an Underwater Facility Lift System. The system proposed is a complete system and meets all the specifications, plus includes many other operational and technical (Cont)

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features. This proposal will provide a narrative description of the technical aspects of the proposed system (including design, fabrication, and installation aspects), drawings, specifications, calculations to substantiate the approach, and a description of our corporate capabilities, structure and experience.

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INTRODUCTION

Enviromarine Systems, Inc., in response to RFTP-78-CO-255, is pleased to submit to CHESDIVNAVFACENGCOM a proposal to provide an Underwater Facility Lift System. The system proposed is a complete system and meets all the specifications, plus includes many other operational and technical features. This proposal will provide a narrative description of the technical aspects of the proposed system (including design, fabrication, and installation aspects), drawings, specifications, calculations to substantiate the approach, and a description of our corporate capabilities, structure and experience.

GENERAL

Enviromarine specializes in products, systems and services relating to the marine environment. As will be demonstrated in subsequent sections, the major portion of our endeavors are total systems and specific devices to deploy, investigate, search and recover with underwater vehicles. Our organization and resources are specifically qualified and geared to provide such end products. The system which we propose will not only meet or exceed the specifications in every respect, but will include added features to improve the performance and usability of the UFLS.

CORPORATE CAPABILITIES, STRUCTURE AND EXPERIENCE

Enviromarine and its personnel have considerable design and field experience with systems similar to the UFLS. Figure A, entitled "Specific Towed Vehicle Related Activities", lists some of the projects with which we have been involved. Enviromarine's key personnel have dedicated virtually their entire careers to such types of applications. Included in the proposal appendix are Summary Resumes which show the extensive first-hand experience which our key personnel have with equipment ranging from long line video and telemtry systems to DC motor control and battery systems. These personnel spend 20-25% of their time in the field implementing and utilizing both Enviromarine's and other oceanographic equipment. They are, therefore, intimately familar by first hand experience with the rigors under which the equipment must perform. In addition, Enviromarine works closely with several major vehicle end-users, the two principal ones being Alcoa Marine Corporation and Ocean Systems, Inc. The vast experience which these and other organizations have accrued in their years of field operation of vehicles is accessible to us and will be utilized throughout the project to even further expand our already considerable in-house experience with such systems.

A Summary Brochure which gives a brief corporate profile of Enviromarine is included in the Appendix of this proposal. Enviromarine's personnel and physical plant have been structured to provide the key

SPECIFIC TOWED VEHICLE RELATED ACTIVITIES

Figure A

Classified Military Project (Deep submergence systems project)

ALCOA SEAPROBE (Total deep sea search and heavy lift recovery system)
- 10,000 foot working depth capability
- Chauvin, Project Engineer - (Conception through utilization)
- Gardner, provided support during later stages.
- ENVIROMARINE
  - Systems Modifications
  - Specialized Systems
  - Field Support
  - General Consulting

Barge "Promise" (Ocean construction platform including suspended systems)
- conversion design details
- systems installation
- products
- check-out, sea trials, preliminary operations

SCARAB (Work vehicle to locate, recover, repair and rebury transoceanic cable)
- Conceptualization
- Requirement Definitions
- Brainstorming
- Technique Itemization and Selection
- Means of Implementation Itemization and Selection
- Detailed "Hardware" Listing
- RFP's
- System Block Diagram
- Formal tradeoff and Recommendation
- Formal Report
- System Cost Estimates

Deepsea Ventures (Deep sea manganese mining instrumentation and operations)
- Concept and General Consulting
- Instrumentation Recommendations
- Specification
- Control Van (Complete layout, fabrication, fitting out, checkout)
- Implementation and Installation
- At-Sea-de-bug and use
- Systems Documentation

HDA/Telemetry/TV System for use on Navy Ocean Construction Platform
UTS Vehicle
Klein and EG & G Side Scan Sonar
Scripps Deep Tow (Side scan, altitude, depth, navigation)
Coring/Seimic Operations

General broad-base overall "Deep Sea Instrumentation" expertise.
Shipyard, cables, cable parameters, handling, controls/displays, materials, pressure compensation, estuary work, enviromental, etc.

necessities for projects of this type while maintaining flexibility to expand if any specific facet of a given project so warrants. The level of participation in the projects summarized in Figure A demonstrates this. Part of this flexibility is achieved by use of outside consultants and subcontractors for specific areas of expertise. One such subcontractor with whom we work closely is Operations Research Inc. (ORI), Silver Spring, Maryland. On projects of this nature, we are able to draw upon their considerable background in program management, technical design review, government contract liason, and financial planning to augment our own staff. A brief description of ORI's capabilities and experience and resumes of its key personnel are included in the appendix of this proposal. An overall project organizational chart is also included to show how the various major tasks associated with a project of this type would be assigned.

Many of the projects referred to in Figure A could be elaborated upon to demonstrate our experience with underwater vehicles and heavy lift systems. One project, the Alcoa Seaprobe, is described in greater detail to illustrate some of this experience.

The R/V Alcoa Seaprobe is a deep ocean search and recovery vessel specifically designed from scratch for this purpose. Several of Enviromarine's personnel (originally under former employ) were involved from virtual conception through utilization. Subsequent

modifications and reconfiguration for various specific operations as well as addition of several new systems which were beyond original budget constraints have been performed by our personnel. This long standing project continues today with Enviromarine providing support as needed. The system consists of an all aluminum 243' mother craft with a center well and pipe handling derrick. The search/recovery vehicle is lowered via drill pipe in order to give large lifting capabilities The search vehicle is of an open frame structure and encompasses such equipment as pingers, 2 TV systems with lighting, forward scan and side scan sonars, film camera and strobes, telemetry, grapple and release systems, passive receivers, etc. A composite umbilical cable connects the system to the surface control room via slip-rings. There the vehicle is controlled and the information is displayed and processed.

One of Enviromarine's personnel, John Chauvin, was responsible for the electronics and electro-mechanical systems from the early conceptual phases through field use. Shortly into the design phase, another of Enviromarine's personnel, Ross Gardner, joined the project, and at one point spent three months at sea with the system. Other of our personnel have been involved to varying degrees with many of its systems over the years. This participation included shipyard installation (while construction was in progress) and initial at-sea checkout, debug, implementation and ultimately at-sea operations.

A similar level of detail can be provided on any of the other projects mentioned. We feel, however, the above summary in combination with the other projects listed adequatelv demonstrates Enviromarine's capabilities in directly related activities. If desired, Enviromarine will be happy to provide similar details on other related projects as well.

Specifically relating to the SEACON, Enviromarine has been involved in this project virtually since its conception. Enviromarine participated in the initial inspection of the Barge "Promise", the system planning, conversion design details, equipment selection, on-board systems installation, provided many of the products on-board, and participated in check-out and some sea-trials. Enviromarine is, therefore, not only most qualified on directly related systems, but specifically familar with the SEACON and its intent.

The close proximity of Enviromarine to both NAVFAC and SEACON will permit maximum intercommunication and project coordination. Since the entire program management, finalized design and actual fabrication will all be done in the Washington, D.C. metropolitan area, there will be ample opportunity for input from NAVFAC throughout the entire project. In addition, with the SEACON located in Norfolk, mobilization requirements will be minimal and the overall installation and training phases of the project can be accomplished very efficiently.

TECHNICAL DISCUSSIONS

Enviromarine proposes to provide a system which is totally responsive to the specification and the needs of the task at hand. In many instances, Enviromarine will draw upon its experience to implement features and characteristics in addition to or superior to the specifications to assure an optimal system.

The specific systems, products and features depicted below have been selected or typified using Enviromarine's first hand experience as the basis. Every type of component or function in this system has been utilized by Enviromarine personnel, some many times over. In many instances , Enviromarine has tremendous experience with the specific piece selected. Each of these items will be detailed below. Enviromarine has chosen components or techniques which have proven themselves to the industry and by first hand experience to Enviromarine. In several places, options are discussed which provide alternative approaches or hardware with tradeoffs. Those items identified as options in the technical proposal will be priced separately in the IFB phase of the procurement for separate consideration.

The designs and calculations included in this proposal are quite conservatively based in that they include large safety factors and assume worst case conditions (e.g.: release, battery and frame weights). It is reasonable to expect that in the detailed design phase of the project many

of these numbers will improve significantly due to final optimization. Enviromarine hastens to point out, however, that even these very conservative numbers meet all the requirements of the specification. Instances where it is felt that final optimization may substantially improve the results of the calculations are so noted in the detailed technical discussions below.

As a matter of simplicity and to assure demonstration of compliance, the format of the specifications will be followed for this detailed technical discussion. Each point will be referred to by its paragraph number and title.

1. SCOPE - Enviromarine fully understands the task at hand. We relate to the application by having the experience described above on underwater work vehicles, familiarity with the SEACON and first hand experience with deployment and retrieval of arrays and structures such as those in AUTEC.

2. APPLICABLE DOCUMENTS - The documents referenced herein, both federal and commercial will be complied with as stated. Most of these are used as guidelines for Enviromarine's normal production. Additional documents not mentioned in the specification which are also used as guidelines for Enviromarine's normal design and quality control practices are MIL-E-16400 and MIL-Q- 9858A.

3. REQUIREMENTS

3.1 System Definitions

3.1.1 General Description - This is self descriptive and similar to many programs we have been previously involved with such as the Alcoa Seaprobe project detailed above. Specifics relating to each subsystem will be given in its respective section.

3.1.2 Mission Summary - The mission as depicted is fully understood. Enviromarine has taken part in many similar missions involving implantment and recovery of various scientific, salvage and test objects as well as arrays. The times as given appear reasonable to somewhat optimistic. Provisions such as battery life will be made to extend such times as much as reasonable. Enviromarine will consider each step in all aspects, especially the specific mechanical configuration, to help assure optimum and efficient performance.

3.1.2.1 Operational Support - The system will be configured such that it may be used aboard a variety of ocean construction work platforms with minimal effort. Many of the requirements of the specifications help assure this. In addition, the disassembly and assembly features such as removable harnessing in the consoles and connectors will be inherent. Containers will be configured for convenient access, yet secure shipment. Regarding installation, Enviromarine has implemented many systems on board various vessels, mostly under the difficult conditions of shipyard

environment. This includes work Enviromarine performed on the SEACON during its conversion.

3.1.4 Systems Diagrams - The figures referenced (1 & 4) are clear and fully understood. Such configurations will be complied with and do not require elaboration. ✓

3.1.4 Interface Definition - Interface will be made as defined in the specifications in the manner given below. see Syst Block Dia ✓

3.1.4.1 UFLS/Platform Interfaces -

a) Electrical Power - The power as stated is satisfactory and will be interfaced with. Any further conditioning required will be provided by Enviromarine. ✓

b) Control Console Components and Space - The existing console was originally provided by Enviromarine. All components of the console will fit into standard 19" wide racks. Racks and consoles such as those Enviromarine provided to the SEACON (Stantron or equivalent) are Enviromarine's standard and have been used on several other projects. ✓

c) Electromechanical Cable Termination - Enviromarine makes several standard winches as well as custom models. Many are delivered complete with terminated cables and slip-rings. Such required mechanical terminations are, therefore, routine and will be made to be compatible with the mechanical connector on the deck winch drum. ✓

3.1.4.2 Functional Interfaces Data - Such interface data will be provided to NAVFAC as early as the detailed designs define them. GFE and SEACON interfaces will also be required by Enviromarine at the earliest feasible date.

3.1.4.3 Mounting Interfaces Data - Such physical mounting interface data as requested and other as reasonable will also be provided to NAVFAC as early as the detailed designs define them. are interfaces identified?

3.1.5 Government-Furnished Equipment List - Enviromarine is very familiar with the types of equipment the government will furnish and is intimately familiar with several of the units. These will become part of the system as described.

3.2 Characteristics

3.2.1 Performance and Physical Characteristics - The UFLS as provided will perform the lift (and lowering) tasks, at least the other functions and will operate at depth as specified. The specifics of the equipment involved are described below.

3.2.1.1 Underwater Vehicle Subsystem - The vehicle will be as requested and as described below. Such items as the steel frame, propulsion, electronics, grappling and gravity stabilizations are to be per the requirements and are detailed below.

a) GFE Pan-and Tilt, Zoom TV Camera, Flood Lights (Not GFE), Film Camera and Strobe - Enviromarine is very familiar with

the Hydro Products RP-3, having encountered or implemented it on many projects. The AC required will be provided by an inverter with at least 50% excess capacity for future light-duty AC loads. Enviromarine is also very familiar with the equipment and has had hands-on use of the Subsea Systems TV cameras, the Subsea Products Strobe Lights and the Hydro Products 70 mm film camera. Mountings for the cameras and lights will be adjustable to accommodate different conditions of different operations. Pan and Tilt motion will not be obstructed and any abscuring of the field of view will be minimized.

b) Non-Zoom TV Camera and Floodlights - The GFE Non-Zoom TV camera and related lights will be mounted per the requirements. Enviromarine has previously implemented the exact configuration described - view clear of the frame yet protected, looking down at a grapple, with compass in corner, with adjustments for changes in the operations and lights configured (spread apart) for minimal back scatter.

c) The sonar as proposed will be described later. In general, Enviromarine's personnel have implemented or utilized many such forward scanning units. It will be mounted above and clear of the pan and tilt assembly working envelope, and its view will be clear of the frame and other equipment.

d) Thrusters - The two thrusters are also described later. Enviromarine has proposed, implemented and utilized many different makes of deep sea motors and thrusters. They will be mounted with wide

spacing, low water flow interference, and minimal camera aft view interference.

e) Battery Containers and Instrument Housings - The containers and housings, described later, will be mounted for accessibility with minimal water flow restriction and minimal camera view obstruction. Such items are Enviromarine's standard products.

f) Release - The underwater load release, as described elsewhere, will be located as specified. The lower end of the load transfer link, also described elsewhere, will be nearby. The link will be positioned and secured as specified and may be removed for hookup of standard rigging for implantment operations.

g) Stabilizers - The stabilizing fin(s) will be mounted on the the aft portion of the vehicle frame in the positions and number that the actual hydrodynamic designs prove to be optimum.

h) Vehicle Attitude - The vehicle will maintain an essentially level attitude. Provisions will be made for some adjustment of the position of some major weight components to accommodate future systems modifications.

i) Dimensions and Weight - The dimensions and weight limitations as originally stated and amended will be met. Such techniques as selection of the batteries with the highest power to pound ratio (except for that excluded in the specifications) have been included since initial inception. Glass sphere type flotation is included to minimize submerged and dry weights.

Figure B shows weight tabulations for the proposed designed. These numbers are quite conservative and will likely be reduced in the detailed design stage.

3.2.1.1.1 Vehicle Frame - The frame shall consist of welded steel structural members. Protection, support, permanent deformation resistance, open cross sections, removable steel grating on top, bolt and nut fasteners, CG on center line through cable, load transfer link and release hook, frame slot, lifting eyes, corner rings, shock absorbing pads and frame finish shall be in accordance with the specifications. Enviromarine's personnel have performed or participated in the fielding of several frames, vehicles and other structures. Additionally, the technology which goes into the standard winch products overlaps in many areas and will be utilized.

3.2.1.1.2 Grapples - Custom units built using standard designs will be used to minimize weight. Load ratings, safety factors, testing, and physical size shall be as specified. Each unit will utilize standard rigging configurations and will be constructed of mild steel.

3.2.1.1.3 Release - The underwater release will hold a load of 100,000 pounds and release from 0 to 25,000 pounds. A dual-redundant electrical control systems similar to the one described in the specifications will be included. The on-deck resettable, non-consumable features should be evident from the description below.

FIGURE B

PRELIMINARY VEHICLE WEIGHT TABULATION

	WEIGHT IN AIR (POUNDS)	WEIGHT IN WATER (POUNDS)
FRAME WITH TRIM & FLOATATION	650	NEUTRAL
GRAPPLES	150	125
RELEASE	475	390
LOAD TRANSFER LINK	20	17
TRANSDUCER SCANNER	45	27
SONAR	47	35
HEADING		
DEPTH } HDA	75	20
ALTITUDE		
TV CAMERA 1	110	80
TV CAMERA 2	37	29
70 MM CAMERA	64	27
STROBE LIGHT	35	29
P/T	120	94
4 LIGHTS	36	28
2 THRUSTERS	300	120 ?
BATTERIES - PROP		
- ELECTRONICS	580 ?	380
- RELEASE		
MISC. ELECTRONICS AND HOUSINGS	90	30
HARNESS AND CONNECTORS	30	15
TOTAL	2864	1446

Various existing turn key products exist which satisfy the specifications. The unit proposed is a modified version of the Interocean Model 5000D Underwater Electric release. This modified unit includes dual redundant motors on the release cam and minor design changes to minimize weight. The weight used in the vehicle weight calculations is very conservative. It is anticipated that the detailed design phase of the contract will yield significant reductions in the final weight of this unit.

The Interocean release proposed requires the least modification of the standard products available to meet the specification. Most standard releases made are of similar cam type design, requiring a few seconds from start of actuation to release. Should NAVFAC desire more rapid release capability, Enviromarine will quote, as an option, a custom designed release which uses techniques which are standard but not presently available as turn-key releases.

3.2.1.1.4 Load Transfer Link - This link shall consist of a stainless steel wire rope fitted with an eye on each end. The working load, ultimate and testing shall be per the spec. The lower end shall accommodate a large shackle or similar device (provided) to be used as the common attachment device. This device in turn connects to the release hook and the load (shackle, grapple or similar). The upper end will be secured by a readily replaceable break away link such that

the upper end is located for easy insertions of a 20 ton crane hook. The break-away link will break when extended in tension. (10)

3.2.1.1.5 Sonar - Enviromarine's personnel have had hands-on personal experience with sonar equipment manufactured by Ametek/Straza, Westinghouse, EG&G, Chesapeake Instruments, Edo Western, Wesmar, Honeywell, Klein Associates, AMF, Innerspace Technology, and others. The sonar proposed is an Ametek/Straza Model 250 CTFM Scanning Sonar. This unit meets the specification and is of proven design. The sonar will be mounted as specified with the field of view stated. All sonar controls, returns and other information will be telemetered via the central multiplex system. Proposed as an option is an EDO Western Corp. Model 4059 OAS-1 Obstacle Avoidance Sonar System modified for the application. This option offers more extended post-processing and display capability than the Straza unit, but it is less competitive.

3.2.1.1.6 Heading Sensor - The two types of heading sensors specified will be provided. Enviromarine has previously implemented a pressure compensated Danforth compass on a deep sea vehicle for viewing by a TV camera. Such a similar proven device will be fielded. The pan and tilt compass will be Enviromarine's standard unit as was previously provided in the "HDA" system for use on SEACON. The digital output will be sent topside via the central telemetry system for display and use by the turns counter.

3.2.1.1.7 Depth Sensor - Enviromarine will provide a Teledyne pressure transducer depth sensor, the same type unit which it previously provided in the HDA system for use on SEACON. This unit meets all requirements of the specification. Its output will be interfaced with the central multiplex system.

3.2.1.1.8 Altitude Sonar - The acoustic altitude sonar to be provided will be of the type manufactured by Innerspace Technology Corp. which Enviromarine also provided in the HDA system for use on SEACON. The specifications for both systems are essentially the same and this unit complies with them both. System operating frequency will be selected so as to avoid interference with the sonar system.

3.2.1.1.9 TV Cameras (GFE) - The cameras will be incorporated and mounted as specified. Controls will be via the central telemetry; each video will be sent to the surface via its own coax member of the umbilical. Long line equalizing amplifiers to drive the cable will be included in the vehicle electronics as required and aligned to compensate for the losses. Enviromarine's familiarity with such cameras and other specifics have previously been discussed.

3.2.1.1.10 70 MM Camera and Strobe Light (GFE) - The film camera will be mounted as specified and controlled from the surface via the central telemetry. Similarly the strobe light will be mounted, powered and

activated as specified. Enviromarine has implemented several film camera/strobe systems and is quite familiar and has coped with such problems as acoustic noise from the strobes and surges on the central power system.

3.2.1.1.11 Pan and Tilt Unit (GFE) - Enviromarine's experience with this unit was previously discussed. Similarly, as previously discussed, the mounting of the pan and tilt unit and the mounting of the TV camera, film camera, strobe, lights and heading sensor thereon will be done as specified.

3.2.1.1.12 Lights - Four deepsea incandescent lamps will be provided. These are to be Hydro Products 250 watt LQ-7 or similar. These meet all the required specifications including, but not limited to, field of illuminations with no hot spots, center beam candle power as revised (1200 CP), life, warm up, and electrical noise. These shall be wired as specified and per Figure 8 of the specs. The power shall be provided through the cable from a conventional, variable, current-regulated DC power supply such as Kepco, Sorenson, Power Mate or other reputable equal. The connectors shall be Marsh Marine and wired as specified. Enviromarine has implemented many types of undersea lights such as incandescent, mercury vapor and thallium iodide, including providing special ballasts and other configurations for special applications.

3.2.1.1.13 Vehicle Propulsion - Two thrusters shall be provided, mounted, powered by the batteries and controlled as specified. Control via the telemetry system will be executed by proportional armature voltage control circuitry using standard switching techniques, thus readily achieving translation (forward or aft) and rotation. EMI and acoustic suppression will be inherent in the controls, cabling, and mounting configuration. Efficiency of the overall thruster assembly will be maximized, especially for slow speeds in order to achieve best rotational characteristics. Ducted propeller units of the type manufactured by either Hoover Electric Co. or Lear Seigler, Inc. rated at 5 HP are proposed. Both of these are standard proven products and will meet the thrust specifications. Propellers will be selected to yield maximum static thrust. Such units are very efficient and approach, if not exceed, the desired design goal of 50 pounds thrust per horsepower.

3.2.1.1.14 Main Vehicle Batteries and Housings - Rechargeable Silver-Cadmium batteries are proposed. Figures C and D show the power requirement analyses for the implant and recovery operations. The larger of these two requirements is the implant operation, and these numbers have been used to size the battery packs. Typical calculations are as follows:

5 HP × 50#/HP = 250# max thrust?
180# specified
∴ why not use smaller motors? more efficient
3½ – 4 shp : avail?

	PEAK POWER (WATTS)		ENERGY (WATT-MINUTES)	
	THRUSTERS	ELECTRONICS	THRUSTERS	ELECTRONICS
ON-DECK CHECKOUT	10K	.500K	5K	1.635K
OVERBOARDING	——	.010K	——	.150K
IN-WATER CHECKOUT AND PREPARATION	10K	.913K	5K	41.5K
LOWERING	——	.538K	——	28K
POSITIONING AND RELEASE	10K	.958K	150K	57.5K
INSPECTION	10K	.508K	100K	5.08K
RECOVERY AND ONTO DECK	10K	.058K	50K	6.27K
TOTAL			310K	140K

FIGURE C

DESIGN BASELINE IMPLANT OPERATION
PRELIMINARY POWER REQUIREMENT ANALYSIS

	PEAK POWER (WATTS)		ENERGY (WATT-MINUTES)	
	THRUSTERS	ELECTRONICS	THRUSTERS	ELECTRONICS
ON-DECK CHECKOUT	10K	.500K	5K	1.625K
OVERBOARDING	——	.010K	——	.150K
IN-WATER CHECKOUT	10K	.913K	5K	5.737K
LOWERING	——	.538K	——	26.6K
SEARCH AND HOOK UP	10K	.958K	150K	77.5K
RECOVERY	10K	.073K	100K	8.070K
LOAD TRANSFER AND ONTO DECK	——	.016K	——	1.320K
TOTAL			260K	121K

FIGURE D

DESIGN BASELINE RECOVERY OPERATION
PRELIMINARY POWER REQUIREMENT ANALYSIS

Peak Thruster Power	10 KW
Peak Electronics Power	958 KW
Required Thruster Energy	5.2 KW-HR
Required Electronics Energy	2.3 KW-HR

With a reserve theoretical capacity of 50%,

Thruster Energy Capacity	7.8 KW-HR
Electronics Energy Capacity	3.5 KW-HR

Allowing for discharge rates, environmental factors, and repeated usage, a 100 volt stack of 100 Amp-Hr cells will be used for the thruster pack and a 32 volt stack of 18 Amp-hr cells will be used for the electronics pack.

Note that a 50% reserve capacity was used in lieu of the 30% specified, thus allowing for greater mission times which may occur periodically. In addition, the original power requirement analysis is quite conservative. For instance, the thruster requirements assume that both thrusters are running at full 5 HP for the entire period of thruster operation given in NAVFAC's specifications. Since amount of retrievable energy is dependent on discharge rate, any reduced power operation periods which may occur during a mission would extend effective capacity in two ways.

The batteries proposed are of deep discharge type and are rated for in excess of 300 cycles with minimum maintenance. Provision is made for charging both battery packs from the surface via the cable

and from separate battery charger (described elsewhere) via separate connector while on deck. Thruster power distribution bus will be isolated from the electronics bus to minimize noise and surge problems. Batteries are protected from overcharging and gassing. Batteries will be packaged in two housings which will include handling provisions. The proposed cells weigh approximately 53 oz's each for the 100 Amp-Hr cells and 13 oz's each for the 19 Amp-Hr cells, which yields a total packaged combined weight of approximately 480 lbs. Housings will be one atmosphere, pressure resistant type with internal hydrocatylators.[7] Provision will be made for purging with dry nitrogen and venting of hydrogen gas. Protected charging connector and leak detectors are provided.

As an option, a system will be proposed which provides the required vehicle power on a continuous basis via a reconfigured EM support cable in lieu of from battery packs as requested.

3.2.1.1.15 Release Batteries and Housings - Two separate battery packs of the same Silver - cadmium type as described above will be provided. They will each be housed in their own separate housings using packaging techniques as previously described. Calculations similar to those given in the previous section show that each complete package will weigh approximately 50 lbs. to give 20 cycle capacity with the same safety factors used above. If desire, a crossover capability will be provided from the thruster power bus to permit use of the thruster

power packs as an additional backup. Provision will be made for testing batteries via the EM cable.

3.2.1.1.16 Electronic Equipment Housings - The electronics will be mounted in separate deep sea housings. These housings will be of the dual access, double O-Ring construction which Enviromarine has provided as its standard product for many years. A purging fitting will be provided to implement the dry nitrogen requirement.

Enviromarine has provided many systems and products for use in the deep sea environment. Therefore, along with the housing, packaging and mounting will be minimal in size and weight.

The volume to accommodate the required electronics plus 1.5 cubic feet volume will be provided along with the spare connectors. High impedence leak detectors as implemented by Enviromarine on previous occasions will be provided and connected to the central telemetry system to sound an alarm topside. The electronics will not be in the same enclosure as the batteries. The anticipated housing size is approximately 8" I.D. x 36" I.W.L. 1.05 ft^3

3.2.1.1.17 Electrical Harnessing and Connectors - The harness and connectors to be provided are of the time proven, high seal reliability, long life units generally available. Typical manufacturers are Vector (Marsh Marine), Envirocon, D.G. O'Brien, Brantner, Kintech, Electro, Burton and Advanced Cable Assembly.

Connectors of the Vector and Envirocon XSL series type are proposed where appropriate. These comply with the individual sealing requirement. Full depth rated mating dummies and plastic locking sleeves will be provided. Enviromarine's personnel have implemented several vehicle harnesses and will incorporate those features which help assure reliability and maintainability. Typical examples of such techniques are running harnesses along and attaching them to protected areas, cushioned wireways, minimized flutter from water flow, accessibility and ample service loops. Pan and tilt flex and abrasion protection and fouling prevention will be provided. Enviromarine's experience in this area has been previously demonstrated.

3.2.1.2 Support Cable Subsystem - The cable to be provided will be manufactured by a reputable underseas cable manufacturer such as Rochester, Vector, South Bay, BIW, Simplex. Discussions with several firms to date on this applicatio have confirmed capabilities and feasibility. Enviromarine's personnel have specified, designed, procured and implemented many different cables for similar applications. All projects listed on the "Specific Towed Vehicle Related Activity" list required such cables with Enviromarine's personnel being highly instrumental in the realization and subsequent utilization of most.

3.2.1.2.1 The proposed cable is depicted in Figure E. This cable provides adequate numbers and sizes of conductors for all power and signal transmission between the surface and the vehicle. Drawing No. D-8503-1 enclosed with this proposal shows the various conductor assignments proposed. These conductor assignments are based on proven techniques which Enviromarine has used quite successfully on past systems and provide adequate design margins for good extended use. The electrical core is of non-hosing design with 100% blocked strands, conductors and intersticies, although a cable with only interticies blocked is quoted as an option due to the negligable technical improvement and tremendous increase in cost which blocking the individual conductors presents. Insulation voltage ratings are detailed in Figure E for the relevant conductors.

The proposed design provides redundancy which permits re-assignment of conductors in the field should the need develop. For example, should one of the coaxes become unusable for some reason, the two television cameras could be easily set up to time-share the same cable by switching between cameras at the bottom via telemetry system commands as desired. In addition, one conductor in the cable is spare.

At frequencies corresponding to 400 TV lines, the RG-11 is well within the drive capability of the conventional long-line amplifiers in the Subsea cameras. Thus, the system will provide better than 400

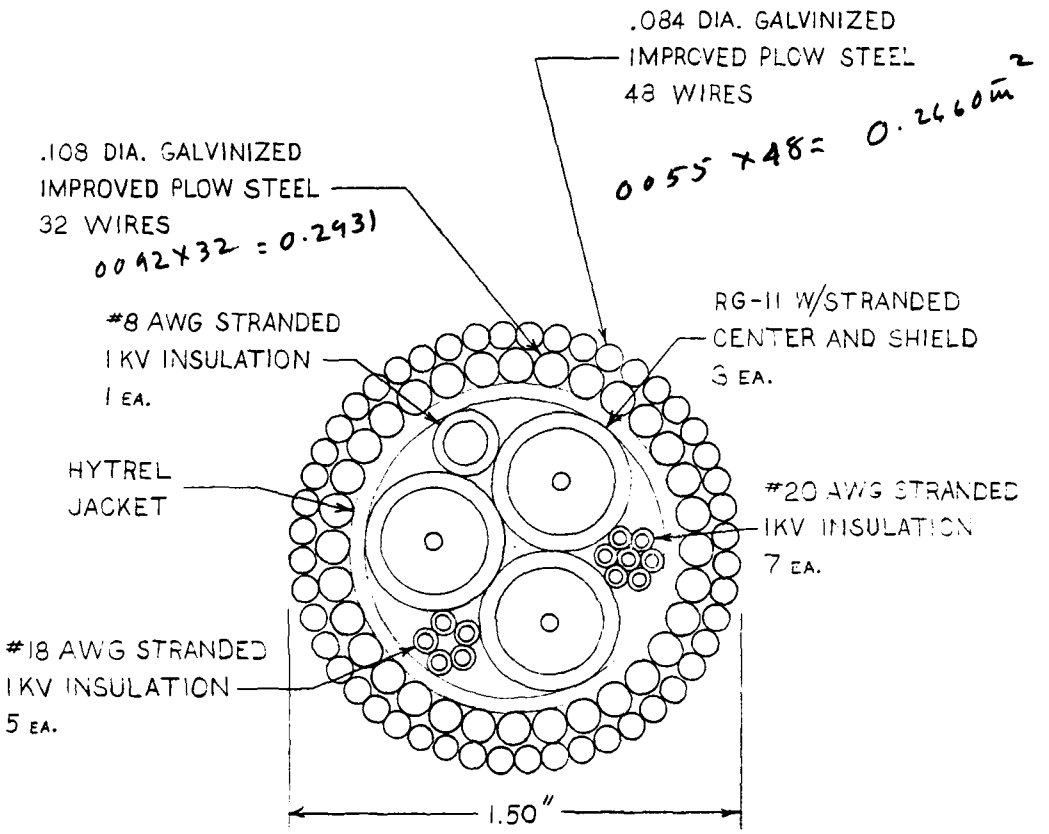


FIGURE E
PRELIMINARY CABLE DESIGN

line performance from either of the TV cameras. In addition, precautions taken which experience has proven prudent such as coax shields isolated from one another and careful power distribution design mean that this system will have minimal noise and crosstalk. Insulation resistance between conductors will be 100 megohms minimum at 500VDC.

As a second option, a 500 line resolution system is quoted which uses additional multiplex equipment and a different cable construction at a somewhat higher cost.

3.2.1.2.2 Support Cable Mechanical Performance and Characteristics - The requirements will be met as follows:

a) Length - 10,500 feet will be provided and such capacities have been confirmed by several manufacturers.

b) Diameter - The 1.5" O.D. spec will be easily met. A 1.4" O.D. cable with 120,000 lb. breakstrength is quoted as an option which, among other benefits, would alleviate any capacity problems which may exist with the present cable winch with only minor level wind changes required.

c) Strength - The working load and breaking strengths will be met with appropriate? safety factors. what factors

d) Armor - as specified. Enviromarine has worked with several types of armor such as double armor (torque balanced and not), single armor, braided, spaced and various synthetics for strength.

e) Bending Radius - The 24" bend radius at 40,000 pounds tension is within the industry-wide accepted standard of 30:1 sheave/ cable diameter ratio and will be complied with.

f) Torque Balance - The 5% differential spec of opposing torques through the stable range has been verified as reasonable and produceable by several vendors. Such will be provided.

g) Termination - Standard terminations such as those manufactured by Preformed Line Products are proposed. These mate with standard rigging hardware for easy removal in the field. Termination on vehicle end shall be corrosion resistant clevis fitting. Electrical connection to vehicle shall be via Marsh Marine MS series connector as per spec.

h) Environment - The environment as stated is normal and reasonable. Proper service will be maintained within those limits.

i) Weight - The exact cable weight will depend upon final design, pack factors and signal requirements. Present calculations anticipate weights of 2800 lbs./M in air and 2200 lbs./M in water.

j) Elongation - The elongation limits described are standard cable design and manufacturing techniques and will be as specified.

3.2.1.3 Shipboard Cable-Handling Subsystem - The requirements and characterics of the GFE and contractor furnished

equipment are understood and are discussed below.

3.2.1.3.1 Cable Winch (GFE) - The drawings, features and performance characteristics of the winch are understood. Enviromarine's personnel have seen the winch while on board the SEACON. Additionally, Enviromarine has built several similar level-wind winches.

3.2.1.3.2 Power and Signal Transfer Equipment - Enviromarine will provide and install an IEL -O-20 slip-ring assembly. This model is specifically designed for use in such enviroments. Enviromarine has exclusively used this type slip-ring on its systems projects and turn-key winches for many years.

3.2.1.3.3 Overboarding and Rigging Sheaves - Three 48" snatch block type sheaves with cable guards as specified will be provided. Enviromarine has traditionally used Johnson Blocks in such applications and such a type or equal is proposed. This block is rated at 44,000 pounds working and 176,000 pound ultimate. One of these sheaves will be used for the cable footage and tension system as described below.

3.2.1.3.4 Cable Tension Measurement - Enviromarine manufactures a standard Integrated Cable Parameter Measuring System which is typically used in applications such as this. Such a system is presently being provided under another contract for use on the Barge SEACON. The in-line tension is measured at one of the sheaves via a load cell at the hook and an angle of departure setting which is dialed in at the control

console. Requirements of maximum tension, safety factor, environment, response time and response senitivity will be met. The standard unit is provided with a digital readout at the master. To comply with the spec, however, an analog meter will be provided at the master unit as well as at the remote. All required cabling will be provided.

3.2.1.3.5 Cable Footage Counter - The Integrated Cable Parameter Measuring System mentioned above includes Enviromarine's standard Cable Payout Indicator. This bidirectional unit complies with the required specifications including function, accuracy, environment and zero reset. A remote digital readout will also be provided. Required cables shall be furnished. Reference the enclosed data sheets which are hereby included in the proposal by reference.

In addition to the Cable Payout and Tension as required and described above, Enviromarine will provide a rate of payout/retrieve indication. This readout will be an analog meter with direction indication and will be at the master unit. This feature is the third standard component of Enviromarine's Integrated Cable Parameter Measuring System.

3.2.1.4 Shipboard Power Unit Subsystem (GFE) - The power supply unit as described is fully understood. Use of this unit for the contractor deliverables on the UFLS are not anticipated.

3.2.1.5 Control and Display Subsystem - Enviromarine is most experienced in designing and implementing control and display systems.

This includes the overall cabinet styles, as well as specific human aspects of control and display placement. All UFLS functions will be controlled from the central control console except those specifically excepted in the specifications. Design and integration of such contractor furnished subsystems will be performed.

3.2.1.5.1 Control Console - The components shall be installable in standard 19" units and will have sufficient interconnect harness lengths to move any drawer to the adjacent bay. The power as stated will be utilized, with any power conditioning as required provided including some additional power for future use. High quality units such as Nova or Topaz will be provided. Proper EMI measures will be taken. The equipment will be installed in the existing control console on board the SEACON which was provided by Enviromarine under previous contract. The additional console to be provided will be similar to that on the existing unit (Stantron or similar). Filtered cooling, louvers or other cooling as necessitated by final designs will be provided.

3.2.1.5.2 Controls - The controls of the UFLS vehicle will be via the central multiplex described later except for certain hard-wired systems.

a) Sonar-Controls as specified and as required will be located on the sonar control/display unit.

b) Vehicle lights - Four toggle switches and a common

intensity control (possibly directly on the power supply) will be provided.

c) Pan and Tilt -Control will be similar to the standard hand held jogstick control provided by Hydro Products.

d) Thrusters - Lockable, spring return proportional control lever will be provided for each thruster giving a range of full-forward to full - reverse. For operator ease an additional knob type control will provide proportional rotation control of the vehicle from full clockwise thrust ? to full counter-clockwise thrust. All three controls will be mounted as Reverse per spec.

e) TV controls will typically be toggle switches located near the respective displays.

f) The three release control switches will be covered toggle switches. The operator must lift the cover of two switches and engage both for actuating. The cover cannot be closed when the switch is "on".

g) 70 MM camera controls will be via toggle switches located on the main operations console switch panel.

h) Altimeter control - toggle switch as above.

i) Batteries recharge current control will be located at that power supply. A variable control will provide a range from zero to at least 30 amps.

j) Digital clock reset controls - as "g" above.

k) Video tape recorder controls. It is anticipated the video

tape recorder will be mounted on the console as pictured in Figure 10. Controls will be located on that respective panel.

1) Audio warning signal suppression control - toggle switch located at the audible signal with visual status indicator.

The GFE winch controls will be mounted in a movable control box as specified.

3.2.1.5.3 Displays - In general, the controls will be located for easiest operator viewing and effectiveness. Related controls and displays will be adjacent and those controls and displays most likely to be used by the respective operators will be grouped on the respective sides. In general, they will be mounted per Figure 10 or other layout mutually agreed upon with the COTR. Where not specifically stated, digital readouts are typically LED or Beckman type displays.

a) Cable tension - 3 1/2" analog edge meter with light.

b) Cable footage out - 0.3" 5 digit LED readout with adjacent reset switch.

c) TV monitors (2) - within one 19" bay.

d) Sonar scope and associated displays - within one 19" bay and placed as pictured.

e) Vehicle heading - as specified.

f) Vehicle turn counter - as specified with adjacent reset switch.

g) Vertical depth - as specified.

h) Vehicle altitude - as stated.

i) Digital clock - as stated.

j) Warning lights - conventional red indicator lamp located for conspicuous viewing, but away from immediate operating panels. Lamp will be "press to test".

k) Vehicle battery voltage and battery current - 3 1/2" analog edge meters with lights.

l) Frame counter - Solenoid actuated mechanical counter located in operations area.

m) Audio signal - Standard beeper such as Mallory Sonalert located away from immediate operating panels.

3.2.1.5.4 Remote Outputs - Video distribution amplifiers such as Dynair will be implemented to drive up to 4 remote monitors (not provided) for both videos.

3.2.1.5.5 Video Tape Recorder - Video switches such as Dow Key or Dynair will provide switching of either video to the VTR and switching the VTR output to either monitor. A 1/2", reel-to-reel Sony 3600 or similar is proposed. This meets the power and resolution specifications and has been used by Enviromarine in similar applications on several previous occasions.

3.2.1.5.6 Digital Clock - Standard clock in conjunction with modified version of video character generator delivered as part of HDA system will be used. Controls and character size will comply with the spec.

3.2.1.5.7 Turns Counter - Vehicle heading will be processed to give digital readout of number of net heading cycles vehicle has made. Controls will be as per spec.

3.2.1.5.8 Multiplex Equipment - The central control console shall contain this equipment as specified. The MUX system is described elsewhere.

3.2.1.5.9 Interconnect Cable - 200 feet of cable shall be provided to connect the control console to the slip-ring as specified. It will be rugged and have a SOneoprene or similar outer jacket. Shielding will be provided if required.

3.2.1.5.10 Operator Interface - Enviromarine's key personnel have spent extended times at sea at the control console of very similar missions and are acutely aware of the necessity of, and have the insight to implement, the convenience, efficiency and comfort of such operators. Such will be done for two non-interfering concurrent operations.

3.2.1.5.11 Telemetry Quality - The proposed system depicted in Drawing 8503-1 has been designed to maximize telemetry quality as described elsewhere. Specifically, the 400 line resolution and low-noise

video have been previously discussed and will comply. Digitized data transmission error rate is typically 10^{-10}. Final testing will be done with the system as described.

3.2.1.6 System Multiplexing - All commands and information except release control and TV video will be multiplexed.

3.2.1.6.1 Capacity - Sonar signals and controls are frequency multiplexed. All other items listed in this section will be multiplexed via the digital telemetry system. This system is similar to the HDA system and is of proven design. Adequate channels will be provided to telemeter all information listed in the appropriate direction.

Multiplexing of the TV video has been previously mentioned.

3.2.1.6.2 Spare Channels - The spare capacity stated will be provided. In addition, the system is expandable to 32 blocks of data each way, with each block consisting of either one 12-bit analog channel or 12 digital commands.

3.2.1.7 Electrical Bonding/Grounding - Grounding as specified will be met, including stated locations, avoiding dissimilar metal common grounding and preventing housing grounds. The entire electrical system shall be isolated from earth ground. Specifically stated ground couples will be provided as well as others as deemed prudent and conformance with the MIL spec as stated will be met. Enviromarine has on numerous occasions encountered the problems of ground loops, corrosion and

electrical grounding hazards.

3.2.1.8 Auxiliary and Support Equipment

3.2.1.8.1 Battery Charger - Charger will be provided as per specifications and enclosed in environmental case suitable for deck use. Charger will also be provided for Release Batteries.

3.2.1.8.2 Special Tools and Instruments - At this time, no special tools or instrumentation is seen as required for operation over equipment which would be part of the standard complement on a vessel such as SEACON.

3.2.2 Reliability - In general, because Enviromarine has such experience in this application and environment, the extreme necessity for long life and proven components, as well as subtleties of design and fabrication are second nature. All such reasonable features will be included.

Methodology — mat'l & comp selection, reliability data consider'y redundancy

3.2.2.1 Design Life - The UFLS and its components shall be designed for ten year lifetime as specified. A reasonable amount of routine maintenance will be required and a few selected components may require replacement including periodic random failures. Batteries and lights will be of high quality but are excepted. Additionally, any other consumable (none presently envisioned) is excluded.

3.2.2.2 Proven Components - In each instance Enviromarine has demonstrated the use of proven components and/or proven designs. In most cases, specific manufacturers or equivalents were referenced. In all cases, hardware supplied by Enviromarine shall be of the highest commercial quality.

3.2.3 Maintainability - As in Reliability above, Enviromarine's field experience has demonstrated the need for ease of maintenance while in the at-sea environment. All reasonable techniques learned throughout the years will be so incorporated. This system is simple, contains no microprocessors, and therefore does not require a computer-level technician to service.

3.2.3.1 Maintenance - On deck or in enclosed work space maintenance possibilities will be maximized.

3.2.3.2 Fluids - At present no fluids are anticipated with the exception of oil for any pressure compensation requirements and lubrication. Fittings will be provided and the number of fluids will be minimized.

3.2.3.3 Accessibility - Experience has shown that inadequate accessibility is probably the most frustrating part of diagnostics and maintenance. All specified and other reasonable features will be designed in. These typically include adequate access and clearance, component

removal, film replenishing, electronic bottle access, battery replacement, access to connectors, test points and mounting fasteners, tool clearance and routine maintenance access.

3.2.3.4 Installation - Incorrect assembly resulting in damage or unsafe conditions shall be avoided by keying, color codes, different bits, etc. Different fasteners shall be minimized and standardization on a single component for use throughout will be done as possible. Blind adjustments will be avoided.

3.2.3.5 Handling - Large, heavy components will be avoided as possible , but where used, lifting attachments or cradle support pads shall be provided.

3.2.4 Environmental Conditions - The stated conditions for the vehicle are reasonable and will be complied with.

3.2.4.1 Operating Environments - Proper performance will be met during and after exposure to the environment appropriate to its function (submersible deck gear or protected control area) as stated. This includes the specifications on Temperature, Pressure, Rain, Snow, Humidity, Salt, Fog, Salt Water, Sand and Dust, and Sea State and wind associated environments. Comments throughout this proposal such as those on pressure housings, finishes, experience, component reliability, etc. apply.

3.2.4.2 Storage (Packaged & Sheltered) - The unit will perform properly after exposure to the environment as specified. These include Temperature, Pressure Humidity, Sand and Dust and Salt Fog.

3.2.5 Transportability - This section is understood and will be complied with .

3.2.6 Storage - Procedures and equipment will be provided as per specification.

3.3 Design and Construction

3.3.1 Materials, Processes and Parts - Materials will be selected as stated. Enviromarine is a systems house and, therefore, routinely looks at the entire system for such possible problems as galvanic couples.

3.3.1.1 Structural Steel - The steel as specified with possible exceptions as allowed will be used. Weldability and corrosion resistance of other materials will be considered. Such material selection is fundamental to all of the systems Enviromarine delivers.

3.3.1.2 Stainless Steel, Aluminum and Other Materials - Any stainless used will typically be of the 300 series - 400 series or 17-4-PH. Aluminum will typically be 2000, 6000 or 7000 series. Other materials will be commensurate with the specifications.

3.3.1.3 Dissimilar Metals/Alloys - Dissimilar metals/alloys will be avoided as feasible. Insulating materials and appropriate fastening techniques will be used where dissimilar metals do occur.

3.3.1.4 Fasteners - Fastener compatibility, isolation and securing thereof will be as specified. Screw threads will conform to NBS Handbook H28.

3.3.1.5 Cable Armor - as specified.

3.3.1.6 Castings - Castings shall be free of stated defects and shall be suitable for the purpose intended.

3.3.1.7 Welding - Welds will be of the best commerical practice, free of injurious foreign matter and will not deform or fail at rated loads.

3.3.1.8 Treatment and Painting - Finishing of frame and untreated components shall be in accordance with the referenced specifications. Color scheme and application of paint shall be as stated.

3.3.1.8.1 Concealed Surfaces - Applicable surfaces will be painted prior to assembly.

3.3.1.8.2 Surfaces Not to be Painted - The three types of areas so stated will not be painted.

3.3.1.9 Lubrication - Lubrication as needed shall be provided as specified including pressure relief fittings and force feed requirements.

3.3.1.10 Fluids - Required fluids will be specified. The nature of these were previously discussed.

3.3.2 Electromagnetic Interference - Compliance with the stated specifications will be made and has been discussed throughout the proposal.

Techniques stated in the specifications are typical of those to be implemented.

3.3.3 Identification and Marking

3.3.3.1 Identification Marking - Will comply with the specifications as stated.

3.3.3.2 Wiring Identification - Such identification will be by the stamped sleeve technique or similar. Such conforms to the specifications and is standard in the deepsea instrumentation industry.

3.3.4 Workmanship - All workmanship will be done in a first class and professional manner.

3.3.4.1 General - General workmanship shall be as specified including references to defective components; repaired or modified parts; welded, bolted and riveted construction, defects and quality.

3.3.4.2 Subassemblies - Subassemblies will fit properly.

3.3.4.3 Fabricated Parts and Components - Shall be free of injurious defects, have uniform welds and be feathered as required.

3.3.4.4 Bolted and Rivited Connections - Proper drilling, deburring, mating, surface fit, matching hole concentricity, rivet sizing and rivet uniformity shall be as specified.

3.3.5 Safety

3.3.5.1 General - Safety will be of utmost importance and will be maximized at all stages. Enviromarine is very safety conscious. It has, for

example, provided several man-rated power circuits for diving chamber life support systems.

3.3.5.2 Diver Safety - Power may be secured to the respective units and others as such operations warrant. This is performed from the Operations Console. The mechanical release preventor will be provided with features stated including an unmistakable indication of mode. Preventor will be flagged to assure removal before descent.

3.3.5 Human Performance/Engineering - The stated MIL spec with the stated exceptions will be complied with. Use of special tools, as well as philosophy and specifics of control console layout were previously discussed. Consideration of the four areas outlined relating to the physical design of mechanical equipment will be done and have been specifically and/or generally discussed elsewhere.

3.4 Documentation - Will comply with the reference specifications.

3.4.1 Preliminary Design Data - The data and calculations outlining the four areas stated will be prepared in the format given and in accordance with the specs as applicable. Three copies will be furnished.

3.4.1.1 Preliminary Design Review Meeting - This meeting will be held at the time, place and in the manner stated. It is Enviromarine's standard policy on such contracts to have such meetings and give the customer the right to review and solicit his comments.

3.4.2 Final Design Data - Such items as final drawings and calculations will be submitted in the form and quantities stated including the summary as required. This shall typically include the six areas stated.

3.4.2 Preparation of Drawings and Data - Such will be prepared, sized, formatted and bound as specified.

3.4.3.1 Catalog Cuts - Catalog cuts will be provided where appropriate.

3.4.4 Operation and Maintenance Manual - Enviromarine will provide Operation and Maintenance Manuals as described in the specifications. This will include but not only be limited to a general description; a complete system level description; theory of operating; installation instructions; operating procedures; a single thread analysis; maintenance procedures; schematics and diagrams; repair and troubleshooting procedures; safety requirements; parts list; tool and equipment lists (special and standard including drawings and description as applicable); disassembly, preservation and packaging instructions; photographs; etc. These manuals will be compiled in keeping with the best commercial practices with drawings as described elsewhere.

3.4.4.1 Manual Preparation - One reproducible and ten copies of the manual described above will be provided, prepared and formatted as required in the specifications.

3.4.5 Progress Reports - Progress reports as specified will be provided. Such are standard procedure to Enviromarine for projects any longer than several months duration.

3.4.6 Recommended Spare Parts List - A list as specified will be provided. In addition those parts which do not have a higher potential of breakdown but are long lead and would create a lengthy down time will be identified.

3.5 Personnel and Training - A training program shall be planned and conducted as described. Training and orientation of personnel upon system delivery is standard procedure for Enviromarine. The maximum permissible training hours established in the cover letter of the RFTP and in the specification itself are more than adequate to thoroughly train the level of personnel involved. The numbers cited for maximum people to be trained are acceptable.

3.5.1 Operational Training - Operational Training - Operational Training Program will include all the points listed plus any others which Enviromarine deems appropriate. Training in simulated operations and actual operational will be scheduled in conjunction with the test phase (4.5, 4.6 and 4.7) and will include actual "hands-on" operation of all contractor-supplied portions of the UFLS.

3.5.2 Maintenance Training - Maintenance training program will encompass all the points listed. In addition, actual troubleshooting exercises will be included in the program along with other "hands-on" exercises.

3.5.3 Training Manual - UFLS Operation and Maintenance manual will be used. Every effort will be made to have the final manual completed in time for the training programs. In the event they are not complete by that time, a draft version will be used which complies with the constraints in the specification.

3.5.4 Training Plan - A detailed training plan containing the points specified will be submitted at least 60 days in advance of such training as requested in the spec. Enviromarine has a great deal of experience in preparing such programs as it has been responsible for military and/or civilian operator maintenance personnel training on virtually all the major programs with which it has been involved.

3.5.4.1 Training Course Limitations - These hour limitations are acceptable as previously discussed.

4. Quality Assurance Provision -

4.1 General Requirements - In general Enviromarine 's quality assurance program starts at conceptual design and goes through shipment and installation. On any given project a specific individual is responsible

for Quality Control management. As specified, a comprehensive plan will be developed, copies submitted for approval, advance notice given and the referenced MIL spec shall be met.

4.2 Responsible for Tests - Contractor responsibility and Government rights are understood and agreed to.

4.3 Examination of Product - Each major subassembly shall be examined for compliance, with any required rework particularly scrutinized and non-compliance causing rejection. Enviromarine makes it a policy to visit various critical vendors' facilities prior to or during the project. On major systems, an Enviromarine representative witnesses a factory acceptance test. Enviromarine has in the past visited most of the probable vendors of the major components for this project.

4.4 Subassembly Tests - Such tests will be performed as stated. Subassemblies will be treated as if separately procured and will be subjected to "acceptance tests" prior to incorporation into the system.

4.5 Operational Tests - The tests listed in the spec will all be performed in the manner described. Additional tests will also be made to thoroughly check out the UFLS system. As is standard Enviromarine procedure, a summary of the testing program for the assembled system will be submitted to the COTR for review and comment well in advance of initiating the testing program.

4.6 Shallow-Water System Test - At-Sea system testing on board the SEACON will be performed as described. Additional shallow

water testing will be performed as mutually agreed upon. Prior to departure for shallow water tests, a brief pierside dunk test program will be conducted to verify system operation as installed. Test program summary was previously discussed.

4.7 Acceptance Test - Deep water testing will be in 5000' minimum water depth. Combined duration of shallow water and deepsea testing will require a maximum of 7 days at sea. Implantments and retrievals will be performed as described. Operation and maintenance shall be by Government personnel trained by Enviromarine. Enviromarine understands the Government will provide access aboard SEACON and will bear costs associated with vessel operation. Operation and Maintenance Manuals as well as test program summary will be delivered prior to acceptance test.

4.8 Test Reporting - Records shall be kept and provided as requested in the specification.

5. Preparation for Delivery - Preparation will be performed as given below.

5.1 Packaging - Packaging will be done per the Federal spec stated with 3 copies of the packing slip respectively provided.

5.1.1 E/M Cable - The cable will be applied to the GFE reel in the manner described which will allow one-time reel onto the winch.

5.1.2 Control Console - The console and components will be packed in respective reusable wood containers.

5.1.3 Vehicle - A cradle as described will be provided. Such features as compatible material, finish, rapid-securing vehicle holddown, access, lifting eyes, lockable wheels, tiedown points, and cover are inherent and will comply with the specification.

5.1.4 Interface Connections, Special Task and Other Deliverable Hardware Items - Items will be packaged and marked as specified.

5.2 Marking - Will be done in compliance with the MIL-STD-129.

5.3 Transportation Procedures - Contractor and Government responsibilities are understood and agreed to.

6. Notes

6.1 SEACON Underwater Work Console - Enviromarine, having provided the existing console, understands its configuration as well as the requirement for the console to be provided. This was previously detailed.

6.2 GFE Description - This description is fully understood and as mentioned, Enviromarine is most familiar with the specific or similar equipment. This is for all the equipment described including:

6.2.1 Cable Winch

6.2.2 Power Supply

6.2.3 Film Camera and Strobe (6.2.3.1 and 6.2.3.2)

6.2.4 Pan and Tilt

6.2.5 TV Cameras

6.2.6 Location of GFE Items - It is understood that the equipment is on the SEACON and inspection arrangements are to be made through CHESDIVNAVFACENGCOM.

EVALUATION CRITERIA COMMENTS

The foregoing should demonstrate to the evaluation team the two general areas required. These are summarized as follows:

Enviromarine's Organization and Resources to Provide the End Products - The section entitled "Corporate Capabilities and Experience" relates Enviromarine's principle qualifications, general experience, specific direct analogous experience, facilities, organization and overall endeavors. Additionally, in the section entitled "Technical Drawings" specific direct experience , knowledge and/or method of performance on each facit, component and technical consideration were briefly mentioned. Such a system is Enviromarine's speciality and the entire corporate structure is oriented toward such deliverables.

Technical Acceptability of Enviromarine's Proposal - The proposal as submitted is entirely responsive to the RFTP. Each point in the specification is specifically commented upon or reference as to be complied with. Specific proven equipment or methods are called out, all meeting the requirements and many superior to or in addition to such requirements. Additionally Enviromarine, without belaboring the mundane, has demonstrated its personal experience on each matter to assure NAVFAC that in addition to meeting the specifications, equipment and methods will be implemented to provide an optimum system ideally suited to perform the task at hand.

Items of Evaluation - Some brief comments are made below regarding the specific items of evaluating listed.

a) General - Enviromarine Systems, Inc. will supply, as a prime Contractor, a complete system, as defined by 3.1 and subparagraphs.

b) Performance Requirement - The system as proposed complies with the requirements as the proposal demonstrates on a point by point basis. This includes all procedures and components required including, but not limited to, those identified as major evaluation emphasis items as follows:

(1) Video - The proposed system is superior, proven, familiar and versatile.

(2) Release - A modified version of a standard release is proposed. An optional release is also discussed. Both are technically superior and assure release when required.

(3) Multiplex - The system proposed uses standard, proven components and has been provided and implemented by Enviromarine several times in the past. The major portion of the hardware consists of Enviro-marine's standard telemetry package (as provided for HDA) with minor configuration modifications.

(4) Sonar - The units and associated equipment proposed are standard and proven.

(5) Cable - The cable design plus selection of such reputable vendors as mentioned assures compliance as described.

(6) Propulsion - Standard deep sea thruster and controls are proposed. EMI and acoustic noise suppression uses conventional techniques.

(7) Load Transfer - Proposed hardware is standard equipment in marine practice and of most straightforward construction and utilization.

(8) Vehicle Power - Batteries proposed are proven units in underwater propulsion applications. Large safety factors for capacity requirement calculations were used throughout. A safe, reliable, low-noise system is proposed.

c) Physical Requirements - Where known or calculated, these have been given. These values comply with or are superior to the requirements. All requirements of the specification will be met.

d) Reliability - Design life and use of proven components have been explicitly detailed and comply.

e) Maintainability - The necessity of maximum maintainability is well known to Enviromarine by field experience and compliance with the requirements has been demonstrated.

f) Design and Constraints - Each point was discussed to verify compliance as well as a demonstration of Enviromarine's use of its experience to the utmost to implement additional details beyond those requested.

g) Planning - Compliance with these sections has been demonstrated on a point to point basis. Enviromarine's standard use of most of these procedures has been demonstrated.

SUMMARY

This proposal is entirely responsive to the RFTP for the Underwater Facility Lift System. It has demonstrated Enviromarine's capability and expertise and has demonstrated technical compliance and superiority of the system to be provided.

In keeping with the Government's usual request for vendors to not provide unnecessarily elaborate proposals, a summary discussion on Enviromarine was given and a point by point technical discussion was made. Supporting information, discussions, examples and details were provided to the extent Enviromarine believes is ample to relate the points discussed without overburdening the proposal with unnecessary details or frill on points which are universally required of companies and systems relating to deep sea technology. Additional boiler plate, details, examples, and explanations are available and will be cheerfully and promptly provided as further requested but are kept to a minimum in this proposal for conciseness.

A specific attempt was made to verify compliance with each and every specification. This was done by direct explanation and/or reference to compliance therewith. Such is the intent of this proposal and the statement below. In the event the Government feels specific point was not confirmed, the following statement will cover such points and will therefore be responsive:

"Enviromarine Systems, Inc. will be totally responsive to and will comply with all the requirements of RFTP-78-CO-255 issued by CHESDIVNAVFACENGCOM". This blanket statement will supercede any deficiencies in the proposal should they occur.

Enviromarine trusts it has demonstrated to NAVFAC that the system to be delivered will be superior, responsive, professional and timely. Above all the specifications given and the details elaborated in this proposal, there is the assurance that the system to be delivered will not only meet the specification, but will be suitable for the purpose intended.

APPENDIX

JOHN A CHAUVIN, JR.

ELECTRONICS ENGINEER

Mr. Chauvin is Vice President of Marketing of this Corporation, Enviromarine Systems, Inc. (EMS). He received his BS Degree in Electrical Engineering from Louisiana State University in 1966 and has also accrued 22 hours of business courses in pursuit of his Master's Degree in Business Administration.

While in this capacity at EMS (6 years), in addition to marketing and sales, Mr. Chauvin has been responsible for all the acts of incorporating, setting up the business structure and gathering highly qualified support personnel. He has provided technical assistance on deep submergence projects and is responsible for much of the design of the electronics and hardware that are produced. He has partaken in various projects on board oceanographic research vessels as well as other military and civilian vessels and workboats. He participates in many undersea projects such as the selection, design and implementation of much of the electronics aboard a Naval Facilities Command Ocean Engineering Platform, Deepsea Ventures Deepsea Miner II, research and systems definitions for SCARAB, new systems work on the Alcoa Seaprobe, etc.

Prior to this, he was employed by Ocean Science and Engineering, Inc. (OSE) for more than three years. Here he was the project engineer for all the deep submergence electronics, related electronics and other custom electronics on board the highly successful all purpose oceanographic research vessel, R/V ALCOA SEAPROBE. This project typically encompassed sonars, underwater film and television cameras, strobe and flood lights, multiplex telemetry, power, control, displays, peripheral equipment and instrumentation. This included administrative, managerial and technical details from initial concept through implementation, utilization and documentation. Mr. Chauvin developed many other designs for proposals (which he helped prepare) and subsequent hardware delivery to the Coast Guard, Navy and private industry.

Prior to this, his experience included almost three years with Westinghouse Electric Corp. in all phases of the development of a prototype classified underseas systems aboard U.S. Navy submarines and workboats, with the emphasis on field application, modification and operation. This included component as well as system design; integration at all levels; developing, re-designing and utilizing the system both in-plant and during extensive at-sea operations; documentation of the system from general schematic to detailed theory of operation; and customer training and cooperative planning.

Mr. Chauvin has held a Secret Clearance, is a certified Professional Engineer, is a NAUI certified SCUBA diver, programs FORTRAN, holds an amateur radio license, is a member of the Marine Technology Society, and the International Oceanographic Foundation, has U.S. Merchant Marine Papers and is married.

ROSS T. GARDNER

ELECTRICAL ENGINEER

Mr. Gardner is President of Enviromarine Systems, Inc. He received his BS Degree in Electrical Engineering from the University of Cincinnati.

While he has been with Enviromarine (5 years), in addition to administration Mr. Gardner has been predominantly responsible for most of the electronics projects. He has been engaged in the design and assembly of new systems for the research vessel ALCOA SEAPROBE. This has included customer liaison, in-house design, fabrication and on-shore/at-sea installation, checkout and utilization of various mechanical and electronic systems. He has been responsible for development of various oceanographic/ marine related products and systems, such as navigation equipment, ship's speed indicator, instrumentation, optics and acoustics systems. He has performed in a similar capacity for a deepsea manganese module mining instrumentation system. He has been deeply involved with systems and devices for use on the Naval Facilities Command Ocean Engineering Platform. This not only includes the electronics but also the participation in and supervision of machining, welding and assembly of the mechanical aspects. He has partaken in many diverse projects on various military, merchant marine, private and government vessels.

Mr. Gardner participated in the Co-op Educational Program while at the University of Cincinnati. While in this program, he worked for the National Oceanographic and Atmospheric Administration (NOAA) for two quarters, Ocean Science and Engineering, Inc. for three quarters, and Reliance Electric and Engineering Company for two quarters.

While at NOAA, he worked extensively on the modification, installation and maintenance of water current flow meters and the associated data reduction by Computer. He supervised and coordinated the gathering of water and bottom samples from various parts of the continental shelf. He has also had experience with their Gulf Atomic deep sea tide gauges as well as their shallow water, land based gauges.

At OSE, Mr. Gardner assisted in designing, assembling, installing, and de-bugging of the instrumentation and telemetry system for the R/V ALCOA SEAPROBE. He has also taken part in at-sea operation of the system for approximately three months.

While with Reliance, Mr. Gardner worked as a Design Engineer for large D.C. motors.

Mr. Gardner is a NAUI certified SCUBA diver, is a private pilot, has his U.S. Merchant Marine Papers, and is a member of IEEE.

A. SCOTT CAPLES

ELECTRICAL ENGINEER

Mr. Caples is Vice President, Technical of Enviromarine Systems, Inc. He received his BS Degree in Electrical Engineering from Johns Hopkins University. His curriculum, however, also included Physical Chemistry, Thermodynamics, Mechanics of Rigid and Deformable Bodies and four graduate credits in Oceanography. While in his present capacity at Enviromarine, Mr. Caples has been primarily responsible for mechanical production, for most of the electro-mechanical designs as well as assuring system compatibility of the mechanical and electrical interfaces on virtually all of Enviromarine's projects. Typically this included winches, structures, deep sea instrument housings, control systems, power trains, chassis, plotter refinements, servo systems, etc. He is also responsible for most of the environmental construction and packaging.

While with the Caples Corporation for five years, he designed and fabricated custom machinery and short run production items. He managed the corporation in all respects including up to six employees ranging from engineers to machinists. Typical projects have included: Deep sea pressure housings made of high yield aluminum and steel, automatic curing ovens, shipboard X-Y plotter (0.010" steps), test and manufacturing for pyrotechnic primer invented and patented by him (while under previous employ), electronics chassis and panel fabrication and assembly, oceanographic winch design and fabrication, a ship's speed log system, etc. The majority of these projects included the drafting and documentation.

He started at Catalyst Research Corp. as a technician in a prototype battery manufacturing project reporting to a project engineer in R&D. Upon the engineer's promotion, Mr. Caples was given the job and successfully completed it. When he was promoted to a project engineer, Mr. Caples was charged with the task of developing new spin-off products and to provide mechanical consultation to other R&D engineers in product and manufacturing design. He remained in Catalyst Research for four years.

While at Western Electric (one year) he was a Systems Equipment Engineer specifying carrier equipment for telephone central offices. While with American Standard, he worked as a draftsman and a light designer.

C. MICHAEL GREEN

ELECTRONICS ENGINEER

Mr. Green heads up the electronics department at Enviromarine. He received his BS Degree in Electrical Engineering from the University of Cincinnatti and is presently working on an MBA.

During his two years at Enviromarine, Mr. Green has been responsible for most of Enviromarine's electronics projects and has headed up some field oriented systems tasks. Such electronics projects included refining Enviromarine's cable payout, rate and tension system; deep sea in-line tension systems; underwater sensor and telemetry systems; still frame real time TV and recording system; etc. He was the project leader on an instrumentation system for mining manganese nodules. This included extended in-field implementations and use.

Prior to this, Mr. Green spent approximately one year at the National Oceanic and Atmospheric Administration as an Engineer in Training. Here he developed sensors and instrumentation for use in the ocean environment, including design and testing of electronic deep ocean remote sensing equipment and shipboard data processing.

While at Cincinnati Electronics Company (1/2 year), he tested and evaluated modules used in digitally controlled signal gear. His work included environmental testing and solution of problems which arose.

JAMES M. ROMAN

SENIOR ELECTRONICS TECHNICIAN

Mr. Roman is a production and field project leader for Enviromarine Systems, Inc. He has completed his Junior year in Electrical Engineering at the University of Akron. He has thus completed not only all the math, chemistry, physics and drafting, but has completed most of his electrical and total requirements toward his degree. He also has training and extensive experience in using metal and wood working shop tools and machines.

During his three years at Enviromarine, Mr. Roman has been responsible for circuit design, component procurement, assembly, QC, testing and implementation of various deep sea related systems. These typically include manganese nodule instrumentations, cable parameter systems, deep sea interface units, controls, displays, etc. He has also been responsible for many operations relating to the machining, assembly, and checkout of hydraulic and electric motor systems such as cable winches. He has spent considerable time in the field implementing Enviromarine's and other's systems and equipment.

While in the Air Force (four years), Mr. Roman received training as an Electronics Technician. He worked on aircraft systems, including troubleshooting, component repair and checkout.

His work at the City of Akron Highway Engineering Department (three years) included street layout drafting and street and property surveying.

EDWARD WINSTON

ENGINEERING AND ADMINISTRATIVE CONSULTANT

EDUCATION

New York University, BSEE, 1961
UCLA, Graduate studies in Business Administration, 1962
Stevens Institute of Technology, Graduate studies in Advanced Math, 1962-1964
University of Utah, Graduate studies in Finance and Accounting, 1968 -1969

BUSINESS EXPERIENCE

Consultant - 1970 - 1978
Specialist in oceanographic instrumentation and systems with direct experience in cable, connector design, acoustic instruments, video (low light level), navigation, geophysical profiling and high resolution data packages. Experienced in both surface ship and submersible instrumentation packages for work, transportation and countermeasure vehicles.

EDO Western Corp. - Director of Marketing - 1967 - 1970
Developed doppler sonar technology for military and commerical application. Responsible for initiating re-entry programs in water depth beginning at 160 feet and finalizing a sonar re-entry system at depths of 25,000 feet (MOHOLE Program). Development of high resolution fiber optic recording techniques for side scan sonar, sub-bottom profiling and spectral analysis. Implemented a program to expand corporate capabilities in all phases of ocean engineering and instrumentation. Provided instrumentation for submersible work and transportation vehicles such as:

Swimmer Delivery Vehicles	(Mine Defense Lab)
Beaver	(North American)
Cubmarine	(Perry Oceangraphics)
Deep Star	(Westinghouse)
Deep Jeep	(Lockheed
Autec I & II	(General Dynamics)
DSSV	(Sperry)
NR - I , II	(Sperry)
Teleprobe	(Naval Oceanographic Office)
Alvin	(WHOI)

General Applied Science Labs - Product Manager - 1964-1967
Responsible for acoustic doppler navigation, specral analysis, analog and digital control system implementation and nanosecond sampling systems for nuclear experimentation. Provided contour control systems for electron beam welding, servo-control packages for industrial film plant automation and corona data acquisition systems for Trans-Atlantic Cable evaluation.

Lockheed Aircraft & Lockheed Electronics Corp. -1961-1964
Responsible for Maintenance and Reliability Studies on P3V aircraft systems including Radar and Sonobuoy indicator. Magnetic Anomaly Detection System (MAD), Inertial Navigation System and Julie-Jezebel System. Supplied maintenance manuals and logic tree repair studies for "in-flight operation". Developed Analog/Digital computer for decoys on Polaris Poseidon and was responsible for maintenance and reliability studies for electro-hydraulic readiness and checkout equipment.

PAPERS PUBLISHED

"Advances in Doppler Sonar for Improved Accuracy, Range and Performance" - Institute of Navigation Journal and MTS Journal

"Underwater Tracking Systems" - Ocean Industry

"Hole Re-Entry System for Glomar Challenger" - Ocean Industry

"Mapping the Ocean Bottom" - Oceanology Intn'l.

"Advanced Sonar Recording Techniques Using Fiber Optic Recorders" - MTS Journal

Thomas "J" Hilton

1357 Canyon Park Road
Bountiful, Utah 84010
(801) 292-3149

EDUCATION

B.S. University of Utah, Salt Lake City, Utah, June, 1960. Major: Electrical Engineering. Strongest emphasis in circuit design and computer technology.

Certificate of Completion, Carbon College, Price, Utah, May, 1952. Major: Machine Shop

BUSINESS EXPERIENCE

Colmek Systems Engineering, Salt Lake City, Utah, January 1978 - present

Program Manager

Program Manager is responsible for coordinating the efforts of the program during the operational phase of the Pilot Mining Test.

During this phase of the program, Colmek Systems Engineering personnel have been responsible for the installation, operation and maintenance of the total Instrumentation System. To date, the system has logged over six months of successful operation.

Colmek Systems Engineering, Seattle, Washington February 1977 - January 1978

Program Manager

Program Manager was totally responsible for seeing that the Pilot Mining Program progressed in a timely manner and achieved the predetermined performance goal. Specific areas of responsibility included scheduling, expenditure of money, approval of technical specifications and performance, coordination of all project people, interfacing with the customer and other members of the Deep Ocean Mining Consortium.

This responsibility involved 30 people and program funding approaching $1,500.000.00.

Colmek Systems Engineering, Salt Lake City, Utah, February 1976 - February 1977

Consultant - Engineering Manager

Objective was to design and manufacture a data acquisition and command system for a tethered vehicle. The system was designed to operate in water depths to 20,000 feet and the communications was carried out over a single twisted shielded pair. The data acquisition system accepted analog or digital

(Consultant - Continued)
data and transmitted it digitally in half duplex mode while analog data was transmitted from the remote vehicle to the main terminal continuously. Digital and analog data was utilized at the surface as inputs to minicomputer/CRT and 8 track digital tape recorders. Conditioned transducers designed for the underwater vehicle included pitch and roll, yaw, water current meter, altimeter, cable tow tension, acoustic pinger and ground speed sensor. Also included was a video system including slow scan TV and 35 MM camera.

System was successfully tested during a 3 month operational phase in 18,000 feet of water.

Edo Western Corporation, Salt Lake City, Utah
1964-1967, 1968-1976

Marketing Manager
Responsible for total marketing effort in this oceanographic instrumentation oriented engineering and manufacturing company. Achieved 1975 gross sales of 6.1 million dollars - highest in company's history. Company is structured such that the marketing personnel not only determine the customers' requirements but also do the system design. Personally responsible for engineering proposals and system design in areas of Seismic Exploration, Oil Well Re-Entry Systems, Instrumentation. Have traveled extensively in the U.S., Europe and South America and have a great deal of experience in actual field operations-both land and offshore.

Division Manager - Instrumentation (1970-71)
Managed a division of 130-180 people. Was responsible for developing a line of commercial products to supplement or replace the declining government product line. This effort resulted in the extensive line of Energy Exploration products. This position was dissolved when four divisions were consolidated into one. Was then given the position of Marketing Manager.

Program Manager (1968-70)
Responsible for the classified government programs involving Doppler Sonar Systems, Fiber Optic Recorders, and various aspects of CAESAR program. Directed the efforts of up to 22 people, including 7 R&D engineers,

(Program Manager Continued)
provided liaison with the customers and also handled any contractual aspects of the programs.

Engineer (1964-67)
R&D Engineer. Designed specialized Electronic/Acoustic instruments. Specialized incircuit design. At this time, Edo Western was in the process of developing instrumentation to complement their existing acoustic product lines.

Electronic Memories, Inc., Salt Lake City, Utah,(1967-68)

Engineering Manager
Electronic Memories manufactured Core Memories for digital computers. Was directly responsible for the testing function and the automatic digital test equipment associated with it. Was also responsible for writing the assembly operational procedures, conducting time and motion studies, and carrying out the quality analysis function. Returned to Edo Western when corporation made the decision to move the Electronic Memories, Inc. facility to Hong Kong.

Sperry-Utah, Salt Lake City, Utah (1962-64)

Engineer
Performed circuit analysis and was responsible for reliability predictions and analysis. Designed special digital systems as trial beds during early engineering R&D efforts.

Librascope Division, General Precision, San Marcos, California (1960-62)

Engineer
Circuit Designer. Designed circuits for CENTAUR and SATURN Guidance Computers.

ORI, Inc.

CORPORATE ORGANIZATION AND FACILITIES

CORPORATE HISTORY

ORI, Inc. (ORI) has provided analytical research and development, engineering and management consulting, computer and information system services to customers in government and industry since 1953. From 1968 to December 1976, the company was a subsidiary of the Reliance Group Incorporated. As of 30 December 1976, all shares of common stock were sold to the employees of ORI through an Employee Stock Ownership Trust. Consequently, ORI is again qualified to provide its services as a small business firm pursuant to the Small Business Act, as amended.

MANAGEMENT ORGANIZATION

The ORI technical staff is organized into five functional operating groups, each of which is headed by a vice president directly responsible to the office of the corporate president. Nine separate operating divisions have been established within these groups to address problem applications related to specific technical and subject matter areas such as strategic and tactical defense programs, space systems, communications systems, and information services and systems. A close-working management committee ensures that all specialized technical skills and expertise of the entire staff of ORI are made available to support any company programs or to supplement project team capabilities whenever required.

STAFF AND FACILITIES

The ORI staff, 60% of whom hold advanced degrees, currently numbers approximately 250, including 165 scientists and engineers representing a wide range of disciplines, educational levels, and technical experience. Representative areas of expertise include mathematics, physics, chemistry, statistics, economics, psychology, political science, engineering (mechanical, electronic, industrial, civil, and aeronautical), business administration, computer and

information systems design and scientific, management and data processing applications, and graphics package development. Additionally, ORI can draw on the expert, specialized services of more than 100 distinguished consultants from university faculties, as well as independent consultants, in any required field.

ORI's corporate headquarters facilities are located at 1400 Spring Street, Silver Spring, Maryland. Other ORI offices are in Bethesda, Maryland and Arlington, Virginia. Several study groups are located at customer facilities in the Washington, D. C. area, at State College, Pennsylvania, and Gaithersburg, Maryland.

In-house technical support capabilities include a publications department providing editorial, graphics and composition services; xerox reproduction facilities with full report publication capabilities.

COMPUTER RESOURCES

ORI has a Harris Corp. 1620 Remote Batch Terminal equipped with a 600 LPM printer and 600 cpm card reader. It employs emulators of the IBM HASP Workstation, the IBM 2780 and the CDC UT200. A 4800 bps data set and a 200 bps data set for communications with commercial and government computers are available. Users may submit batch jobs via TSO, WILBUR, etc., with the output routed to the remote batch terminal. ORI uses several time-sharing services employing the BASIC, FORTRAN, and APL languages for which eight 10 to 30 cps terminals are available. The data sets connect to IBM 360/65, 370/145, and 370/155 computers, with an aggregate of 5.25 MB of memory. The data sets also connect to CDC 6500, 6600, and 6700 computers.

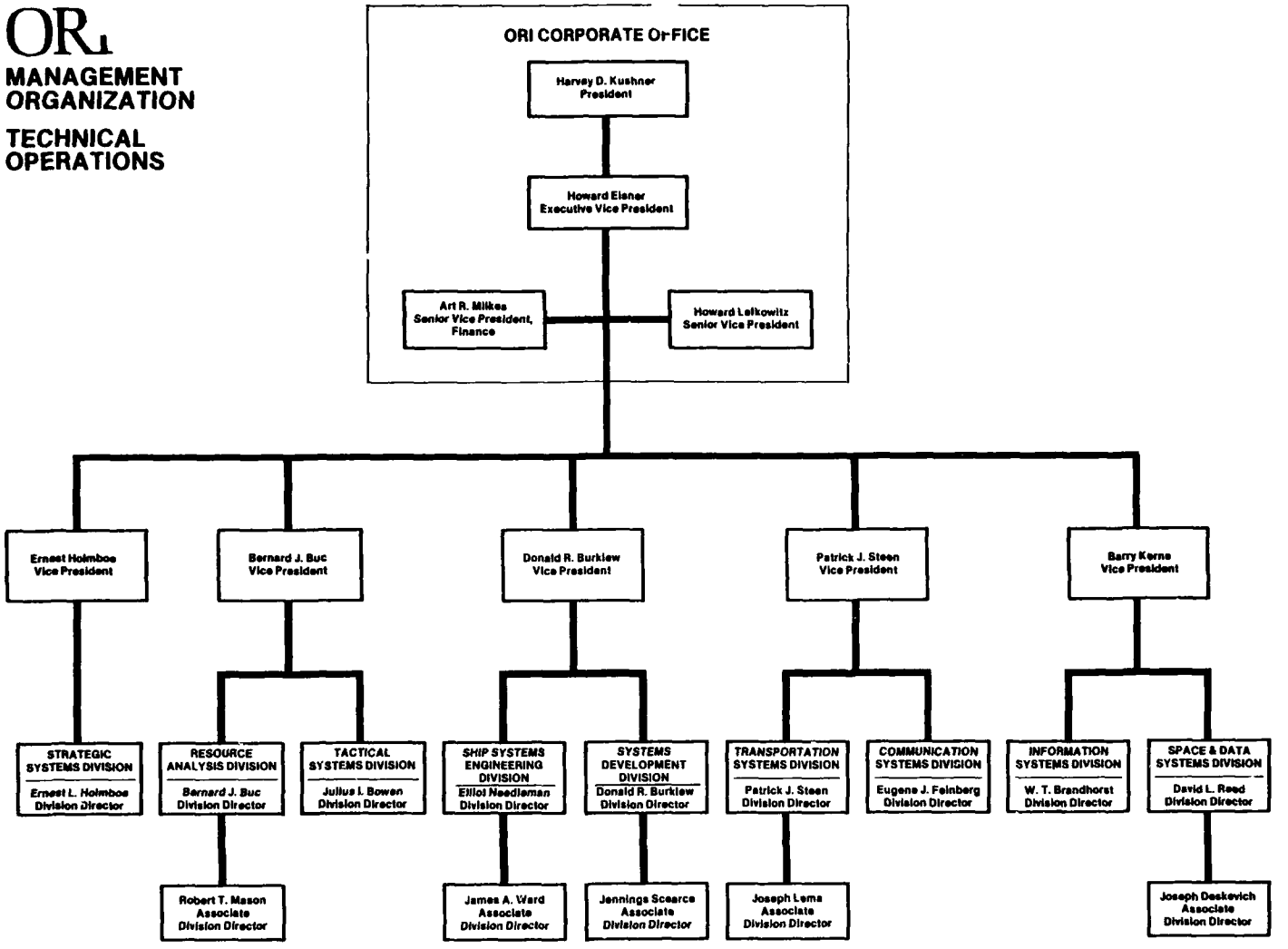
PROGRAM LIBRARY

ORI possesses a library of approximately 130 thoroughly tested generalized programs and subprograms, some of which have been selected from various computer user libraries, and others developed by our own personnel. Most of these programs and subprograms are written so that they may be used with little or no modification on any computer with FORTRAN and COBOL compilers. ORI also possesses or has access to software packages from commercial, government, and in-house sources.

ORI

MANAGEMENT ORGANIZATION

TECHNICAL OPERATIONS



APPROVED: H. D. Kushner
FEBRUARY 1, 1978

EDUCATIONAL PROFILE OF ORI TECHNICAL STAFF AND MANAGEMENT PERSONNEL*

DEGREE DISCIPLINE	DEGREE		
	BS	MS	PhD
Accounting	3	-	-
Business Administration/Public Administration	6	8	1
Computer Sciences/Data Processing	3	4	-
Economics/Econometrics	2	2	-
Education	1	-	1
Engineering:			
Aeronautical/Aerospace	8	5	-
Chemical/Chemistry	9	-	2
Civil	2		
Electrical	31	21	3
General	3	1	
Marine/Naval Architecture/Ocean	4	3	1
Mechanical/Control Systems	10	7	3
Systems/Industrial	1	1	1
General Science	1	1	-
Law	-	2	-
Library Science	-	5	-
Mathematics/Applied Math	22	4	3
Military Science/Naval Science & Engineering	4	1	-
Operations Research/Operations Analysis	-	2	-
Physics	23	12	12
Political Science/Int'l Affairs/Government	3	3	1
Psychology	4	3	-
Sociology	2	1	-
Statistics	-	-	-
Other	14	6	-
TOTAL DEGREES	156	92	28
Non-Degreed Personnel	20		
Total Staff*	179		

As of March 31, 1978

DEPARTMENT OF DEFENSE (DOD) CONTRACTS SUMMARY

• OFFICE OF THE SECRETARY OF DEFENSE	$ 1.895 M
• U.S. NAVY	$36.649 M
• U.S. ARMY	$ 9.229 M
• U.S. AIR FORCE	$ 2.159 M
TOTAL VALUE OF DOD CONTRACTS, 1955-1976	$49.933 M

ORI

III. QUALIFICATIONS AND CAPABILITIES

The Ship Systems Engineering Division and Systems Development Division of ORI, Inc., possesses the expertise and background necessary to provide engineering and management support in a wide range of technical disciplines. Particularly, the two divisions has the experience and capability within its current staffing to provide support in the following areas:

- COMPUTER SOFTWARE AND HARDWARE

  Systems Analysis and Requirements Definition
  Advanced Technology Applications
  WS 8506 Rev 1 and SECNAV INS 3560.1
  CMS-2Y, CMS-2M
  UYK-7, UYK-20, Microprocessors
  Design Review and Analysis
  Digital and Hybrid Computer Systems Design and Support
  Conceptual Design
  Configuration Management
  Documentation Review and Preparation
  Quality Assurance
  Software Verification and Validation
  Real-Time Software and Executive Systems

- ASSURANCE ENGINEERING

  Quality Assurance
  Reliability Analysis
  Maintainability Analysis

- CONTROL SYSTEMS ENGINEERING

  Optimal Control
  Linear Systems Analysis
  Digital Control

Filtering and Identification
Vehicle Control
Stability Augmentation
Operator Modeling

- LOGISTICS SUPPORT

  ILS Management
  Supply Support
  Logistics Analysis

- MANAGEMENT SUPPORT

  Configuration Management
  Cost-Effectiveness Analysis
  Data Bank Management
  Data Management
  Engineering Analysis
  Program Evaluation and Review Techniques
  Proposal Development
  Program Planning
  Program Management Support
  Technical Analysis and Review
  Technical Writing and Editing

- MATHEMATICAL, PHYSICAL SCIENCES, AND ENGINEERING

  Acoustics
  Experimental Data Analysis
  Fluid Dynamics
  Operations Research
  Probability and Statistics
  Seaway Modeling
  Simulation Studies
  Time Series Analysis
  Electronics and Electrical Engineering
  Ocean and Marine Engineering
  Hydrodynamics
  Naval Architecture
  Human Engineering
  Plasma Spectroscopy

- TEST AND EVALUATION

  Acceptance Testing
  Test Plans
  Test Procedures

- TRAINING SYSTEMS

  Acquisition
  Development
  Conceptual Design
  Test and Acceptance

ORI personnel have been providing the Navy with technical support across many engineering disciplines for several years. Brief descriptions of selected areas of contract experience are summarized in this section. More extensive summaries of these contracts may be provided if requested.

SUBMARINE MOTION EQUATIONS

- Submarine Equations of Motion Evaluation. An extensive evaluation of [illegible] of motion was carried out [illegible] made to take into account [illegible] CG location. A major [illegible] equations is being [illegible] launch submarine [illegible]

SURFACE SHIP BRIDGE CONTROL SYSTEM CPPS

- ORI is assisting [illegible] completion [illegible] Specific [illegible] Control [illegible] a [illegible] for [illegible] This [illegible]

SUBMARINE CONTROL DATA BANK

- [illegible]

COMPUTER SYSTEMS DEVELOPMENT AND MAINTENANCE SUPPORT

- [illegible] Analysis [illegible] this area [illegible]

  -- Adaptation [illegible] ware configuration [illegible]

-- AN/UYK-7, AN/UYK-20 and SIGMA 9 hybrid evaluation

-- Adaptation of a plot package for the INTERDATA computer

IMPROVED CONTROL OF ADVANCED SUBMARINES

- ORI did a study on Partial-Span Sternplane Flaps for the Imporved Control of Advanced Submarines (ICAS) program. The objective of this study was to assess and evaluate the implications of the partial-span sternplane flaps configuration from an operational viewpoint, both on the general basis of its application to any submarine design and the specific basis of its comparison to the existing SSN 688 design.

ASCOP

- ORI personnel have furnished support to DTNSRDC in the planning and development of the Advanced Submarine Control Program (ASCOP). ASCOP has been established to define, initiate and implement a long range research and development program encompassing the total field of submarine control.

[illegible] SHIP POWER [illegible]MISSION/PROPULSION [illegible]TEM TECHNOLOGY

- ORI is doing a review of advanced naval ship power transmission/propulsion system technology. A Technology survey and literature search of present and developing main propulsion systems applicable to all foreseeable naval surface platforms of the post-1980 fleet is being conducted. The survey will provide the Technology Base manager and decision maker an understanding of technical feasibility; developmental and production risk, ship design/flexibility advantages; vulnerability issues involved; and RDT&E production and lifecycle cost trends.

[illegible] NAVY SEAKEEPING EVALUATION

- ORI is assisting the Surface Ship Dynamics Branch (Code 1568) DTNSRDC in preparing, conducting, and evaluating a fleet survey on seakeeping problems of U. S. Navy ships. The data collected by the survey will be used in other R&D tasks to incorporate seakeeping criteria into the ship design process

TRIDENT TECHNICAL, ENGINEERING, AND MANAGEMENT SUPPORT

- ORI is furnishing technical, engineering and management support to NAVSEC 6165D for the development and integration of the TRIDENT

Ship Control System. NAVSEC 6165D is the Participating Manager (PARM) for the TRIDENT Ship Control System software with General Dynamics/ Electric Boat Division as the development contractor. The following paragraphs list some of the work being performed by ORI.

ORI personnel assist NAVSEC 6165D in monitoring the progress of the development contractor including preparing action item status lists, attending progress review meetings and holding discussions with cognizant Navy and contractor personnel. ORI personnel review all Ship Control Application Program (SCAP) documents to ensure that it conforms to the SCAP as delivered. They review program listings to ensure that the programming has been done in accordance with TRIDENT standards and conventions. All SCAP documents are reviewed to detect potential Command and Control System integration problems.

In the area of Configuration Management, ORI reviews and analyzes the development contractor's Configuration Management Plan for conformance with appropriate Military Standards, prepares configuration audit guidelines, reviews and comments on SCAP Engineering Change Proposals (ECPs) and Specification Change Notices (SCNs), maintains a record of SCAP ECP status, monitors other subsystem ECPs for impact on SCAP and attends SCAP Change Control Board meetings.

In the area of Test and Evaluation, ORI reviews and comments on SCAP test plans and procedures, prepares and maintains a dependency network, provides on-site support for acceptance testing at the EB Div SCAP Facility. ORI monitors the hardware/software integration of the Ship Control Station, Signal Data Converters and Position Control Units with the Ship Control Application Program and the Simulation Evaluation Program. This included reviews of test plans and procedures, conduct of testing and evaluation of test results.

The Ship Control Application Program (SCAP) is being integrated into the TRIDENT Command and Control System at the Land Based Evalua-

tion Facility, NUSC Newport, Rhode Island. Software Test Problem Reports and Tests ECPs are evaluated by ORI for SCAP impact.

ADSCS PROJECT MONITORING

- ORI is providing similar support to the development of the SSN 688 Aided Display Submarine Control System (ADSCS). The ADSCS is being developed by the Autonetics Division of Rockwell International. ORI monitors the efforts of the contractor, reviewing all WS-8506 documentation, monitoring PERT progress and the contractor's Configuration Management.

TRIDENT SHIP CONTROL ANALYSIS

- Under a separate contract, ORI is supporting NAVSEC 6165D in the test and evaluation of the TRIDENT Ship Control System. This task covers the entire Ship Control System hardware as well as software. ORI is defining the Ship Control System, identifying system interfaces, identifying test requirements, identifying tests scheduled, reviewing and commenting on Contractor Test Specification Requirements (TSRs) and Test Procedures, and preparing a Ship Control System test plan.

SUBMARINE DEPTH EXTENSION FIVE-YEAR DEVELOPMENT PLAN

- For NAVSEC Code 6141D, ORI is preparing a Five-Year Development Plan to extend the depth capability of submarine machinery systems. This task requires reviewing and analyzing the task statements for 19 different ship systems, identifying possible system interactions and interdependencies, establishing program management procedures and producing the development plan.

TRIDENT SHIP CONTROL SYSTEM TRAINER PROCUREMENT

- ORI is providing support to NAVSEA PMS 396 in the management of the TRIDENT Ship Control System Trainer procurement. ORI is identifying and acquiring pertinent data for the Trainer contractor, Sperry Systems Management. ORI maintains a record of data transferred between the TRIDENT Ship Control System contractor and the Trainer contractor and provides the Trainer contractor with design and performance changes.

SOFTWARE DEVELOPMENT MONITORING

- ORI provides monitoring of the software development performed by the prime contractor, Sperry Systems Management. This includes software design reviews and reviews of software documentation for conformance to WS-8506 Rev. 1.

PMS-396 PROGRAM MANAGEMENT SUPPORT

- ORI is also providing program management support to NAVSEA PMS 396. This involves software development management and technical evaluations of software designs and documentation generated by a subcontractor, Sperry Univac.

  These software projects are developed for the AN/UYK-7 and AN/UYK-20 computers, are programmed in CMS-2 and ULTRA, and use both standard and unique real-time operating systems.

ASCOP ENGINEERING SUPPORT

- ORI is providing management and engineering support to NAVSEA 0322 for the advanced Submarine Control Program. ORI's present tasks include evaluation of data from simulated submarined maneuvering, development of criteria for submarine control system and operational evaluation of submarine force producers.

SHIP CONTROL MAINTENANCE TRAINER

- ORI is developing the concept for the TRIDENT Ship Control Maintenance Trainer and will be responsible for developing an "A" Level Specifications and Computer Program Performance Specification for the TRIDENT Ship Control Maintenance Trainer.

SUBMARINE DESIGN CONCEPT

- ORI developed a design concept for a nonnuclear submarine. This task included mission analysis, design and cost tradeoffs.

SUBMARINE DESIGN CONCEPT ASSESSMENT

- ORI developed methods of assessing the operational implications of new ship design concepts, including the development of an evaluation methodology based on criteria related to the total mission of the craft, determination of the platform design parameters, sensitivity analysis, and an illustrative application of methodology to hydrofoils.

TOWED ARRAY ANALYSIS

- ORI for several years has been performing assessments of towed arrays. Using computer models and simulation, ORI personnel have analyzed the use of towed arrays in tactical situations, analyzed sonar characteristics, calculated beam patterns and indices, and studied sonar signal processing.

MARK 48 TORPEDO ANALYSIS

- ORI has been providing engineering and analytical support of the Mark 48 Torpedo Weapon System project for the Applied (Ordnance)

RESUME

Elliot Needleman
ORI, Incorporated

AREAS OF ACTIVITY: Program Planning

EXPERIENCE:

1977 - present
ORI, Incorporated, Silver Spring, Maryland
Division Director, Ship Systems Engineering Division (1 year)
Responsible for technical management support for the Naval Ship Engineering Center and Naval Sea Systems Command. Directing systems analysis work for the TRIDENT and SSN 688 class submarines. Supervising eighteen engineers, analysts and logistics experts.

1973 - 1977
Naval Sea Systems Command (PMS-396), Washington, D.C.,
TRIDENT Project Engineering Management Director (CCS) (4 years)
Responsible for all aspects of design and acquisition of the TRIDENT Submarine Command and Control Systems. Supervised fifteen engineers and logistics and budgetary experts.

1969 - 1973
Naval Ship Systems Command (PMS-393), Washington, D.C.,
Naval Architect (4 years)
Ship acquisition planning, scheduling, evaluation, monitoring and integration. Supervised four naval architects.

1968 - 1969
Naval Material Command (PM-1), Washington, D.C.,
Mechanical Engineer (1 year)
Engineering support for ship maintenance and repair problems. Supervised two engineers.

1966 - 1968
Mare Island Shipyard, Mare Island, California
Quality Assurance Section Head (2 years)
Responsible for quality assurance and component standardization. Supervised twelve technical personnel.

1962 - 1966
San Francisco Naval Shipyard, San Francisco, California,
Mechanical Engineer (2 years)

1958 - 1962
New York Shipbuilding Corporation, New York, New York,
Cooperative Student (4 years)

Elliot Needleman

EDUCATION:

Drexel College, 1958-1962, B.S. in Mechanical Engineering.

HONORS AND PUBLICATIONS:

"Chlorine Stress Corrosion in Seawater Systems" Report for Buships, 1961.

"Radiographic Inspection of Copper-Nickel Castings in Sea Water System" A Report for the Naval Material Command, 1968.

"Silver Brazing of Several Bronze Alloy Casting" A Report for the Naval Material Command, 1968 (with others).

RESUME

P. Jennings Scearce, Jr.
ORI, Incorporated

AREA OF ACTIVITY: Contracts Manager

EXPERIENCE:

1976 - present
ORI, Incorporated, Silver Spring, Maryland
Associate Division Director (2 years)
As the Associate Director of the Systems Development Division, is responsible for the administrative and technical management for contractual support to DTNSRDC, NAVSEC and NAVSEA. These efforts involve modeling and simulation of the dynamics of Advanced Naval Vehicles, design and implementation of ship control systems for TRIDENT and SSN 668, analysis of the Submarine Machinery R&D Program, operations analysis of Navy Logistics Systems, and management support of the TRIDENT Ship Control Trainer Development Program.

1973 - 1976
ManTech of New Jersey, Washington, D.C.
Executive Director (3 years)
As Technical Director of Washington Operations, as Director of Washington Operations and finally Executive Director of ManTech Systems Division, was responsible for technical and overall supervision of up to 150 engineers, operations analysts, scientists and management engineers. Major emphasis during this period was on cost analysis of Navy missile programs, analysis (including LSA&LORA) of the logistics needs of major procurements, development of tactics for combatant ship, management and technical support to the NAVMAT automatic test equipment program, and the analysis and recommended solutions of Navy energy and environmental problems. In addition, was responsible for contract administration, cost/budget control, and administration of employees and corporate matters.

1963 - 1973
Vitro Laboratories, Silver Spring, Maryland

1971-1973 (2 years)
Group Supervisor
Served as the Group Supervisor of the NAVAIR Systems Group. In this capacity, was responsible for the technical and administrative supervision of a large group of engineers, analysts, staff specialists and management assistants who were involved in developing policy and procedural handbooks for NAVAIR and in providing consultant services to various NAVAIR customers. Specific projects being pursued were the Red Sparrow Program, all Target/Drone development

programs, various ground support equipment development programs and an integrated logistics support management system. Functional efforts supervised included logistics review and monitoring, test planning, test data analysis and program planning.

1968-1971 (3 years)
Assistant Group Supervisor, Systems Development Group
Responsible for the technical and administrative supervision of a group of engineers and analysts who were involved in the development of new generation Naval Warfare Systems. Projects pursued were the Point Defense Missile System, the Target Acquisition System, the NATO Sea Sparrow Missile System, and the Concept Formulation of a Hydrographic Survey Ship System (AGS).
Additional group efforts included studies of integrated logistic support, missile improvement programs and development of program management handbooks for various NAVAIR activities.

1966-1968 (2 years)
In support of the Navy Ship Command, was involved in systems analysis leading to the development of new generation Naval systems. Was responsible for threat analysis, mission and performance definitions, system effectiveness studies, and cost analysis. These tasks culminated in the conduct of cost-effectiveness and trade-off studies necessary for use in the writing of Proposed Technical Approaches (PTA). More specifically, served as the systems analyst for the Concept Formulation of a Mine Countermeasure Support Ship System.

Served as the team leader of a group of analysts who proved the feasibility and the effectiveness of using helicopters for part of the Navy's mine sweeping mission.

Served on the Navy's Advanced Point Defense Study Group as a member of the threat and evaluation subcommittee. Assisted in the definition of the system threat in the post 1972 time frame, and described and analyzed the systems considered as candidates for the Advanced Point Defense Weapon System.

As Section Leader, supervised a section of analysts involved in Concept Formulation of new weapon systems, as well as new ship systems. The section was responsible for supporting the Departments within the guided missile branch in the area of systems analysis. Functional capabilities included mission refinement studies, cost analysis, reliability analysis, performance and effectiveness trade-off studies, and system sensitivity studies.

1965-1966 (1 year)
Provided contractual support to the Navy's Surface Missile System Project Office in the area of Ship's Qualification Tests (SQAT) and Development Assist Tests (DAT). Recommended test areas, defined test procedures, and published project reports describing the test objectives and results. Also was responsible for test instrumentation installation and checkout. Served as weapon systems engineer and as

weapon system advisor during a four month at sea evaluation of the TARTAR system. In this role, was responsible for the total weapon system operation, and determining and resolving problem areas during a simulated enemy attack.

1963-1966 (3 years)
Was engaged in the development of tolerance definitions and error analyses of surface missile systems. Conducted error analyses of the electronic units and the electro-mechanical servo units of systems analog computers. Developed methods for including the effect of component errors in a digital simulation of the system, and coordinated the programming effort needed to establish the simulation. Responsible for developing the method to evaluate the effort needed to system output errors on the probability of target acquisition by a missile. Was responsible for other areas of the tolerance development project, including a transmission line study and a probability of test evaluation risk study. Developed computer programs to evaluate these areas and wrote engineering project reports defining the studies and their results.

EDUCATION:

North Carolina State University, B.S. in Electrical Engineering	1959-1963
Bolt-Beranch-Newman, Systems Engineering Studies	1967

HONORS AND PUBLICATIONS:

"Error Analysis of Servo Systems Utilization in the MK 118 TARTAR Fire Control Computer," 1964.

"Target Flight Profiles and Firing Plans for Use in TARTAR OPEVAL Missile Firings," 1965.

"Static Tracking Simulation of the TARTAR Fire Control System: Math Model and Simulation," 1965.

"Static Tracking Simulation of the TARTAR Fire Control System: Users Manual," 1965.

"Preliminary Analysis of the TARTAR OPEVAL Conducted Aboard USS DDG 19," 1966.

"Mission and Threat Analysis of a Mine Countermeasures Support Ship System," 1967.

"System Effectiveness and Cost Effectiveness Studies for a Mine Countermeasures Support Ship System," 1968.

P. Jennings Scearce, Jr.

"Mine Countermeasures Support Ship System: An Analysis of Alternative and Competitive System Concepts," 1968.

"An Analysis and Prediction of the Dynamics of Encounter Between a Moored Mine Sweeping Cable and a Mine Mooring," 1968.

"Performance and Effectiveness Analysis of a Coastal Hydrographic Survey System," 1970.

"System Performance Requirements for a New Generation Hydrographic Survey System (HSURCH)," 1970.

"Cost Trade-Off Analysis of Alternative Concepts for a Coastal Hydrographic Survey Ship," 1970.

"Program Master Plan for an Integrated Logistics Support System (ILSS) for NAVAIR," co-author, 1971.

RESUME

William D. Taper

ORI, Incorporated

AREA OF ACTIVITY: Program Planning and Procurement Documentation

EXPERIENCE:

1977 - present
ORI, Incorporated, Silver Spring, Maryland
Principal Staff (8 months)
Mr. Taper directs ORI's effort in support of the Navy's formal ASW Centers Command and Control System Operational Evaluation. The effort involves the coordination of all testing activities, data collection and analysis of a major Automated DOD Command and Control system. Mr. Taper is also responsible for conducting a Life Cycle Support Costing Study as well as developing a management information reporting system, both of which will be utilized by the TRIDENT submarine subsystem program manager. The Life Cycle Study will utilize the following analysis in determining the total life cycle costs: Work and Cost breakdown structures, PERT and CPM scheduling, Programming Planning Budgeting System and Five-Year Defense Plans (FYDP) assessment. Mr. Taper works independently in providing support in the above areas.

1973 - 1977
Science Applications, Inc., McLean, Virginia
Director C^2 Information Group (4 years)
As Director of the C^2 Information Group, directed SAI's effort in the support of NAVELEXSYSCOM'S (PME-108) developmental/C^3 program acquisitions. This effort supported the following programs, Navy Command and Control System (NCCS), Ocean Surveillance Information System (OSIS), ASWCCCS, Tactical Flag Command and Control (TFCC), and Work With Military Command and Control System (WWMCCS). Mr. Taper has directed and contributed technically to the following tasks:

- Documentation Development:
  - ASWCCCS: Developed all major documentation required to support the acquisition process, i.e., Integrated Logistics Support Plan, Test and Evaluation Master Plan, Navy Training Plan, Navy Decision Coordinating Paper, and System Description.
  - NCCS, OSIS, WWMCCS: Reviewed and critiqued all design documentation in accordance with the MIL Standard documentation WS 8506 and Navy instructions 4720.17M.

- Quarterly Briefs to Program Sponsor: Prepared for NAVELEXSYSCOM quarterly briefs for PM-4 (Program Sponsor). Briefs included status of all contractual, financial, and technical aspects of the various programs under development.

- Test Plan Development:
  - ASWCCCS Technical Evaluation Test Plan
  - ASWCCCS Operational Evaluation Test Plan
- Hardware and Software Testing:
  - Conduct/supervise DT-1 software module testing
  - Conduct of the ASWCCCS Technical Evaluation
- Systems Analysis:
  - Developed the interface specifications and applicable documents defining the interfaces between two major C^3 systems and their associated automated networks.
  - Developed a matrix methodology for assessing the performance of a C^3 network during the conduct of an Operational Evaluation.
- Program Planning:
  - Corporate: Financial control over all project related monies ($20,000 per annum). Planning involved W.B.S. and scheduling to maximize the utilization of SAI personnel. Responsibilities also included interface and negotiation with Contracting Officer.
  - Navy Program Support: Performed project assessment utilizing PERT and CPM networking as well as assisting in the preparation of the Program Objectives Memorandum (POM), Five-Year Defense Plan (FYDP), and Extended Planning Annex (EPA).

1972 - 1973
Analytics, Inc., McLean, Virginia
Lead Environmental Systems Analyst (1 year)
Mr. Taper was the head environmental systems analyst in charge of all efforts in environmental analysis. These efforts were directed at the government and private sector, and including marketing, submission of proposals and basic research.

1971 - 1972
The American University, Washington, D.C.
Graduate Student / Assistant to the Director of Environmental Studies
While at The American University, Mr. Taper's work included the development of a monte carlo pollution model for a river environment (the model generates decomposition and recovery zones as well as

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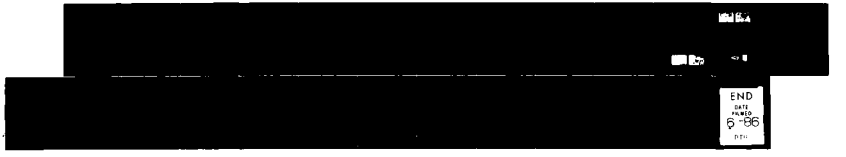

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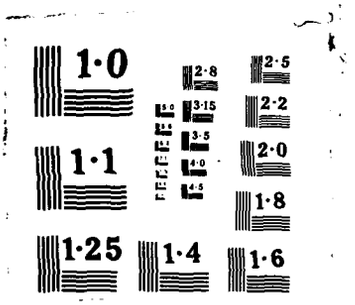
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indicating the DO level at fixed monitor stations); the writing and analysis of environmental impact statements for municipal airports; providing support to the Director of Environmental Studies by calculating automotive emission dispersions for several new highway systems; and the development of a new environmental simulation course to be taught at The American University.

EDUCATION:

The American University, M.S. in Comprehensive fields: Management Information Systems and Environmental Systems Management	1972
University of Maryland, B.S./B.A. in Business Management and Economics	1971
Peninsula College, A.A. in Mechanical Engineering	1963
Basic Flight School, U.S. Navy	1965
Advanced Flight School, U.S. Navy; Commissioned Ensign	1965-1966

HONORS AND PUBLICATIONS:

"A Systems Approach to Environmental Assessment," Environmental Management, November 1972.

RESUME

John R. Ware
ORI, Incorporated

AREAS OF TECHNOLOGY: Technical Analyses, Reviews and Reporting

EXPERIENCE:

1976 - Present
ORI, Incorporated, Silver Spring, Maryland
Senior Scientist (2 years)
Applying modern systems theory to advanced naval craft including structural load alleviation on hydrofoils (PHM-1), steering controls for surface ships (DD-963) and steering and diving controls for submarines. Also providing technical assistance for contract monitoring on the implementation of Aided Display Submarine Control System of the SSN 688 class submarine.

1971 - 1976
David W. Taylor Naval Ship Research and Development Center, Bethesda, Maryland
Project Manager (5 years)
In charge of control system development in the Dynamic Simulation Branch. Control system development in this sense is the production of the dynamic equations relating input vectors to output vectors for vehicle control. During this period control systems were produced for the AGEH-1 (300 ton experimental hydrofoil craft), course and depthkeeping for the TRIDENT submarine, the U.S. Navy's newest attack class. All these control systems will be digitally implemented and were developed using optimal control techniques. The TRIDENT system represents the first vehicle controller in the liquid bourne Navy which was developed using advanced techniques.

Technical consultant to the project monitor for the SSN 688 system participating in all phases of software development and testing. Also provided technical assistance to the project monitors on the TRIDENT and AGEH-1 control software development efforts.

John R. Ware

Worked in the simulation area, especially hydrofoils, and developed an interactive program that "wrote" hydrofoil simulation programs.

1965 - 1971
University of Michigan, Ann Arbor, Michigan
Research Assistant (6 years)
Graduate studies in the areas of random processes, control theory, and experimental psychology. Thesis dealt with the application of optimal prediction to adaptive modelling of human behavior in simple control tasks. As research assistant managed the NASA technical library and assisted graduate students in hybrid and analog programming for dynamic system simulation. As a teaching fellow taught Analog Computation in Control System Analysis and Introduction to Analog Computation to graduate level students.

1963 - 1965
Ford Motor Company, Detroit, Michigan
Engineer (2 years)
Investigated and designed advanced leak detection systems which included work in high vacuum technology. Also worked on fastener development and analysis.

University of Detroit
Teaching Fellow
Taught courses in gas dynamics, basic measurements, and report writing.

Served as a consultant in investigations of motor vehicle (specifically Corvair) stability. Designed and built miniature force balance system for small-scale wind tunnel, simulation of vehicles, high speed photography, test driving etc.

1960 - 1963
U.S. Bureau of Mines, Wyoming
Inspector (3 years)
Worked as surveyor and inspector (concrete, mechanical systems, piping, etc.) on Flaming Gorge and Glen Canyon Dam Projects.

John R. Ware

EDUCATION:

University of Detroit, 1957-1963, B.S. in Mechanical Engineering

University of Detroit, 1963-1965, M.S. in Mechanical Engineering

University of Michigan, 1965-1971, Ph.D. in Control Systems

HONORS AND PUBLICATIONS:

"An Input Adaptive, Pursuit Tracking Model of the Human Operator (I)," Proceedings of the Sixth Annual Conference on Manual Control, April 1970.

"An Input Adaptive, Pursuit Tracking Model of the Human Operator (II)," Proceedings of the Seventh Annual Conference on Manual Control, June 1971.

"GHOSIP: A New Tool for the Investigation of Hydrofoil Control," Third Ship ControlSystems Symposium, September 1972, Bath, England (with G. Gale and V. Ryba).

"Application of Optimal Control Theory to Ship Steering and Control," Proceedings of the 17th American Towing Tank Conference, June 1974.

"Discrete Versus Continuous Control Design for Digital Controllers: A Review of Experience," Fourth Ship Control Symposium, October 1975, The Hague, Netherlands.

"Application of Linear-Quardratic-Gaussian Control Theory to Submarine Control," Proceedings of the First Naval Ship Control Symposium, June 1975, Monterey, California.

RESUME

F. Earl Rich

ORI, Incorporated

AREAS OF ACTIVITY: Preparation of Procurement Documentation

EXPERIENCE:

1973 - present
ORI, Incorporated, Silver Spring, Maryland
Program Director 1975 - present
Presently assisting DTNSRDC in preparing a survey of fleet personnel on seakeeping problems of U.S. Navy Ships. Providing management support to NAVSEA 0322 for the Advanced Submarine Control Program (ASCOP). Providing management support to NAVSEC 6165D in the implementation of the TRIDENT Ship Control System software and test and evaluation of hardware/software interfaces. Also providing management support to NAVSEA (PMS 396) in the development of the TRIDENT Ship Control Trainer. Providing management support to NAVSEA (032) Submarine Machinery Deeper Depth Program. Support in these programs has included the development of procurement documentation and assisting in the proposal review cycle. RFP's have included a submarine test vehicle, Hydrofoil navigation Collision Avoidance System, and a 7 year R and D study for submarine machinery systems.

Consultant to ORI 1973 - 1975
Prepared the data base for the Submarine Control Data Bank, Naval Ship Research and Development Center (NSRDC). Wrote the management plan for the development of the ship control systems for the TRITON class submarines for the Submarines Control Division, NSRDC. Currently supervising 8 junior and senior engineers.

1967 - 1973
Computer Sciences Corporation, Falls Church, Virginia
Senior Member, Technical Staff (6 years)
Performed operational and systems analysis. Participated in the design and development of an on-line, real-time nuclear damage assessment system for the National Command System of the Department of Defense, and was the team leader in the development of the operational system. Participated in the development of a concept for a national communications system for the National Communications Agency. Managed the NASA Technology Utilization Survey Program. This program published surveys that made NASA technology available to the public and private industry. Participated in the selection of topics, selected authors, and edited and prepared final manuscripts for this program.

F. Earl Rich

1964 - 1967
Documentation Incorporated, Bethesda, Maryland
Chief, SDI Branch (3 years)
Engaged in EDP information retrieval at the NASA Scientific and Technical Information Facility. Worked on the design and development of computer retrieval systems, specifying systems requirements and capabilities, and prepared documentation for system operation. As a branch chief, managed two "current awareness" programs that retrieved and announced current reports of interest to NASA scientists and engineers.

1941 - 1964
U.S. Navy
Ensign to Captain (22 years)
Served 22 years in the U.S. Navy, retiring with the rank of Captain. During last tour of active duty was assigned to the Joint Chiefs of Staff, National Military Command Systems Division as Battle Staff Team Chief. In this capacity, was engaged in developing and testing operations and emergency procedures, the day-to-day operation of the Military Command and Control System, and participating in worldwide military command and control exercises.

During naval career, served as communications officer, engineering officer, executive officer, and command officer aboard submarines. Also commanded a destroyer and served as operations officer on a battleship.

Served as Congressional liaison officer in the supply and logistics area for the Office of the Secretary of Defense. Prepared and conducted courses in International Law and International Relations at the Naval War College. Also supervised the publication of three books on International Law. While attached to the Office of the Judge Advocate General of the Navy, obtained a law degree and was admitted to the District of Columbia Bar.

EDUCATION"

U.S. Naval Academy, 1937 - 1941, B.S. in Electrical Engineering

George Washington University, 1947 - 1950, L. L. B.

RESUME

Paul W. Schmitt
ORI, Incorporated

AREAS OF ACTIVITY: Program Planning, Preparation of Procurement Documentation, and Liaison and Coordination.

EXPERIENCE:

1976 - Present
ORI, Incorporated, Silver Spring, Maryland
Associate Program Director for Simulation and Engineering Support Section and Naval Architecture and Marine Engineering Section (24 months)
Responsible for the mathematical modeling of ship motions and digital simulation studies for Advanced Marine vechicles. Responsible for the development of both hardware and software documentation; the types of documentation have included project design histories, system functional descriptions, computer program performance specifications, maintenance manuals and user's guides. Provide assistance in the area of procurement documentation (including procurement planning, specification development, documentation requirements, preparation of RFP, evaluation criteria, synopsis and source selection) to various NAVSEA and DTNSRDC technical codes. Supervising seven naval architects, marine engineers and computer programmers. Responsible for technical liaison and contract administration related to the simulation and Enineering Support Section and the Naval Architecture and Marine Engineering Section.

1974 - 1976
Raytheon Service Company, Hyattsville, Maryland
Engineer (17 months)
Involved in configuration management and integrated logistics support in the development of Navy Systems. Responsible for the development of configuration management plans, change control procedures and retrofit procedures. Provided engineering analysis and management support in the change control process. Responsbile for the technical iaison with the Change Control Board (CCB) chairman and for the presentation of recommendations to the CCB board. Monitored system acquisition contracts and maintained project status accounting records. Coordinated a technical and editorial review of the "AN/UYK-7(V) computer set equipment specification"

Paul W. Schmitt

1970 - 1974
United States Navy, Supply Corps
Ensigr to Lieutenant (43 months) (Supply Officer)
Responsible for logisics management, procurement, inventory management, contract monitoring and budgeting while attached to U.S. Naval Station Guantanamo Bay, Cuba. Supervised 32 technical and non-technical personnel.

EDUCATION:

Loyola College, 1966-1970, B.S. in Physics

University of Maryland, 1974-1976, studies in the field of Chemistry (20 semester hours) and Environmental Sciences (12 semester hours)

The John's Hopkins University, 1976-1978, MS in Computer Science

Navy Supply Corps School

Navy Personnel Management Course

Defense Procurement Management Course

RFP Planning, Writing, Executing Conference

HONORS AND PUBLICATIONS:

"Development History of Hydrofoil Collision Avoidance and Navigation System," Nov., 1977, sole another, ORI Report

"Ship Motion Performance Assessment Program" April 1978, co-author, ORI Report

"A Ship Work Breakdown Structured Summary of Hudrofoil Crewmen Debrietings," May 1977, sole another, ORI Report

"Functional Description of the Surface Ship Bridge Control System," March 1977, sole another, ORI Report

"Manual for Seakeeping Performance Assessment," April 1978, co-authored 50%; ORI Report

MEMBERSHIP:
U.S. Nval Reservc: DLA Depot 106
mob. des. contracting/procurement officer DDOU

ENVIRONMENTAL

Telephone
Telephone (301) 498-8833

PAYOUT INDICATOR

INTE MEASUREMENT SYSTEM

ENVIROMARINE SYSTEMS, INC.

SCOPE

Enviromarine is primarily engaged in the design, manufacture and operation of electronic, electromechanical, and mechanical products and systems for the ocean environment. The structure of the organization, the facilities, and the background of the personnel are all geared toward the ocean marketplace and enable us to deal easily with both custom and standard systems and products. Our past and ongoing involvement in field work allows us to provide to our customers equipment and systems which are optimum for the ocean environment. Enviromarine's broad technical base and experience means that we can work comfortably and efficiently in the many areas of ocean-related endeavor. Let us be of service to you.

CAPABILITIES

The diversity of Enviromarine's capabilities in the ocean environment is due primarily to our strength in three areas—sound technical background, extensive experience, and streamlined, flexible facilities. With these three tools, we can quickly and easily shift from one area of ocean technology to another, an important capability when working with a complex system or when trying to develop new hardware to solve a customer's specific problem.

Since our incorporation in 1972, we have used highly qualified ocean-oriented personnel throughout our technical staff with most having many years of actual field experience from which to draw. Areas of technical expertise within this group cover virtually the entire spectrum of ocean-related electrical and mechanical hardware technology. This combination of technical background and practical field experience provides the perspective required for imaginative designs suited for field use.

Enviromarine's facilities are also oriented specifically toward ocean technology. With our extensive electrical and mechanical design and fabrication capabilities, the customer can be assured of good communication between the design and fabrication operations, which along with communications with the customer himself allows maximum flexibility and provides optimum results. Our in-plant testing and quality control facilities incorporate a wide range of equipment, including temperature chambers vacuum chamber, test tank, tension and compression calibration bench, and numerous other pieces of standard electronics and mechanical test equipment. When actual field testing is deemed necessary or desirable, nearby Chesapeake Bay often becomes our workshop.

ORGANIZATION

Enviromarine has an aggressive, efficient management program which serves to regulate the operation without crushing it with overhead. The strong technical background of the personnel involved in the management functions provides the understanding and insight necessary to accurately schedule and deliver first-rate products. Constant vigilance assures that deliveries are met, that costs are controlled wherever possible without compromise to quality, and that high reliability is maintained throughout. In-house design, fabrication, testing and quality control supported by our broad capabilities and experience assures maximum control and customer satisfaction. Our products and systems are backed by a liberal warranty which is the customer's guarantee of quality, dependability and performance and his assurance that what he is receiving conforms to specification and, more importantly, his needs.

Service, adjustment or defective parts replacement is done on an expedite basis whether at the factory or in the field. Factory and/or field training of customer's personnel on equipment or systems can be arranged. Field service and support by our technicians or engineers is available at any place in the world.

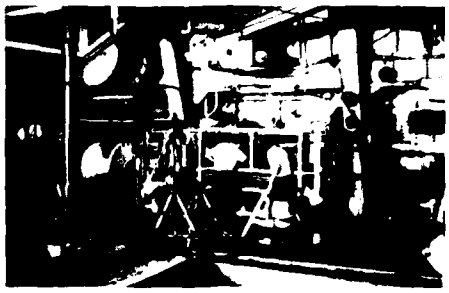
Enviromarine's marketing program is set up primarily for direct sales and sales through our local representatives. Since ultimate customer satisfaction is often determined by how clearly his desires and needs are understood, every effort is made to work with the prospective customer as closely as possible from the very beginning to determine what his needs are. This assures the end result will be optimum for his needs both in characteristics and performance. To assist in this process, Enviromarine has local technical representatives in all geographic areas of major ocean activity in the United States.

SYSTEMS

With Enviromarine's comprehensive design, fabrication and testing facilities, we are highly qualified to perform system design and integration on any level from direct consulting to complete resonsibility for the system design, implementation and field operation. Our wide experience in the ocean industry and continual interface with the customer throughout the project assures that the system will be optimally suited to the task it is to perform.

Because our personnel are field oriented, Enviromarine can work easily from either operational or technical specifications on systems varying in size from quite small to extremely large and complex. A diverse technical and field background has enabled us to work on a wide spectrum of systems ranging in operating environment from ship and shore based to the deepest ocean depths; in size from a few days consulting to several-man-year projects involving total system design, fabrication and utilization; and in philosophy from short lifespan prototypes to high reliability diver support systems.

Since the most obvious solution is not necessarily the best solution, integral with every design program is an analysis of various alternative system designs. This "brainstorming" phase early in a project often results in a system which is superior technically, operationally and economically to one built along the lines of what would seem to be the "obvious" solution. Good design practices such as this and encouraging customer input throughout the project give results which have earned Enviromarine a reputation throughout the industry for providing quality, operational systems at an economical price.



SERVICES

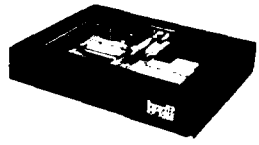
At Enviromarine we operate what we build and what we don't build. Field operation, technical field support, base support and project management are major components of the services package which we offer. Our personnel are available to go to any part of the world to provide the needed manpower and expertise, even on a short notice basis.

One major group of field services which we offer is the installation, troubleshooting, operation, and repair of ocean-related electronic, electrical, and mechanical systems. Our personnel are available for any of these tasks, or they can take responsibility for and perform the entire equipment fielding and operation from start to finish. Enviromarine's years of experience in this area covers the entire spectrum of working conditions and assures that the job will be performed quickly and satisfactorily.

To back up our field operations, Enviromarine has developed an excellent base support capability to provide field personnel management as well as data reduction and analysis. As either a stand-alone service or in conjunction with our own field personnel, our project administrators provide the technical and management background to make field activities run smoothly and efficiently. Our diverse data reduction and analysis capabilities permit us to minimize data handling costs by applying the appropriate level of sophistication to each process.

Our third major group of services is in the area of field studies and the retrieval of information. Whether the task is to retrieve samples and raw data for customer processing or to do the complete job ourselves, the qualifications of our field and base personnel are the customer's assurance that the information he receives will be accurate, thorough and systematic.

WINCH



SHIPBOARD
X-Y PLOTTER

CABLE PAYOUT
INDICATOR

CUSTOM PRODUCTS

With the specialized expertise of our personnel, as well as equipment and facilities designed and laid out specifically for ocean oriented applications, Enviromarine is well qualified to deliver custom products for the customer's needs. Working primarily in the areas of custom field equipment, test fixtures, and complete portable work shelters, our background and experience in these areas enable us to provide high quality equipment at an economical price.

From beginning to end, we take great care to be certain that what is built will be suitable for the application. First, we work extensively with the customer to establish what is to be accomplished both technically and operationally. Then the brainstorm session takes place, the equipment is designed, breadboarded, fabricated, checked out, aligned, tested and delivered with all supporting manuals, literature, etc. Enviromarine draws upon its expertise to include subtle features not immediately apparent or specifically stated in order to assure an optimum product for the application. Close liaison is maintained throughout the project to assure that the customer gets what he needs, what he thinks he is getting and that it performs in the manner intended. Feedback resulting from use in the field aids in assuring optimum performance of the delivered equipment and, if possible, subtle improvements for future units.

Many of Enviromarine's present standard products have resulted from either custom products, systems or field work. In instances where Enviromarine feels there is a potential market for a product and its complements the existing line, Enviromarine shares or entirely absorbs the development costs in order to deliver the first unit to the field. In this manner, the customer gets a custom product designed specifically for his needs priced as if it were a standard existing product.

Enviromarine's production and fabrication capabilities are run by graduate engineers. Because of this, not only are we able to build print, but we are able to relate to what is being fabricated and therefore contribute to assuring that what is being built will ineed perform well. The customer thus benefits from our expertise and has the added assurance that inherent in the fabrication process is the feedback of ideas, often resulting in a finished product better suited to the application.

PRODUCTS

Enviromarine's product line complements the systems and services well. In many instances, specific products evolved from or were a direct result of these other endeavors. Because of our systems and field oriented work, we are able to incorporate operational features in the product at the design and manufacturing levels to assure reliability and proper performance. Extensive in-house testing, customer feedback and, in many instances, at-sea operational use of these products by our own personnel has resulted in continued subtle improvements.

Our Shipboard X-Y Plotter, for example, is designed specifically for shipboard navigation purposes. Not merely a computer room plotter made to work at sea, its materials and rugged construction are designed to take shipboard conditions. Operational features which field experience had shown to be desirable were included, such as the inverted plotting technique which permits obstruction-free view of the plot as well as simultaneous use of the unit as a plotter and conventional chart table. This technique allows disposal of an existing chart table where space is at a premium. Such considerations are inherent in our entire product line.

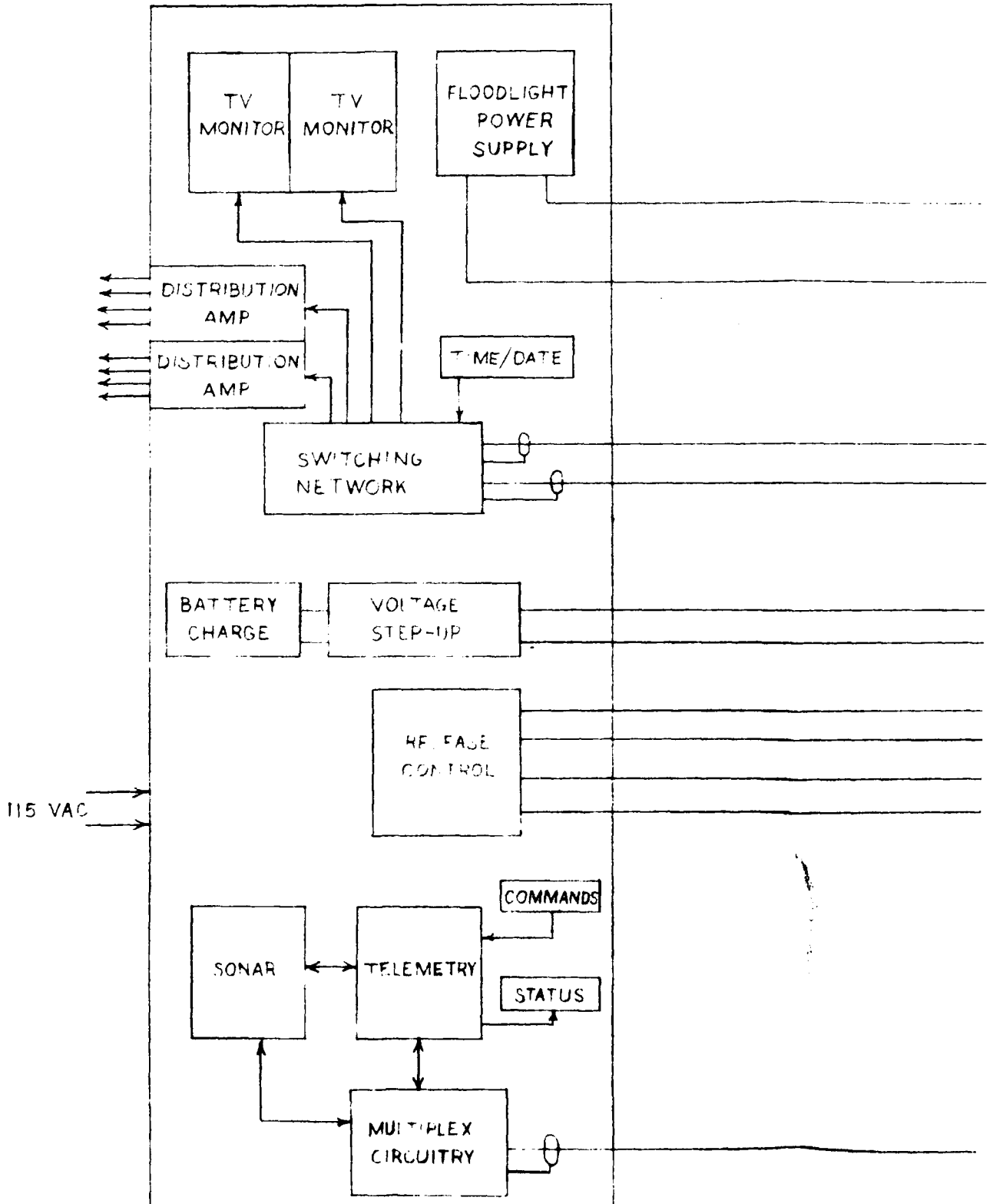
Our Cable Parameter Measurement System is also specifically designed for ocean-oriented application. It measures cable length out (feet, meters, fathoms, other), cable rate, and line tension. The sensors can be mounted remotely from the electronics. Splashproof design, corrosion resistance, etc., is inherent. The sensors are intrinsically safe for use in hazardous environments.

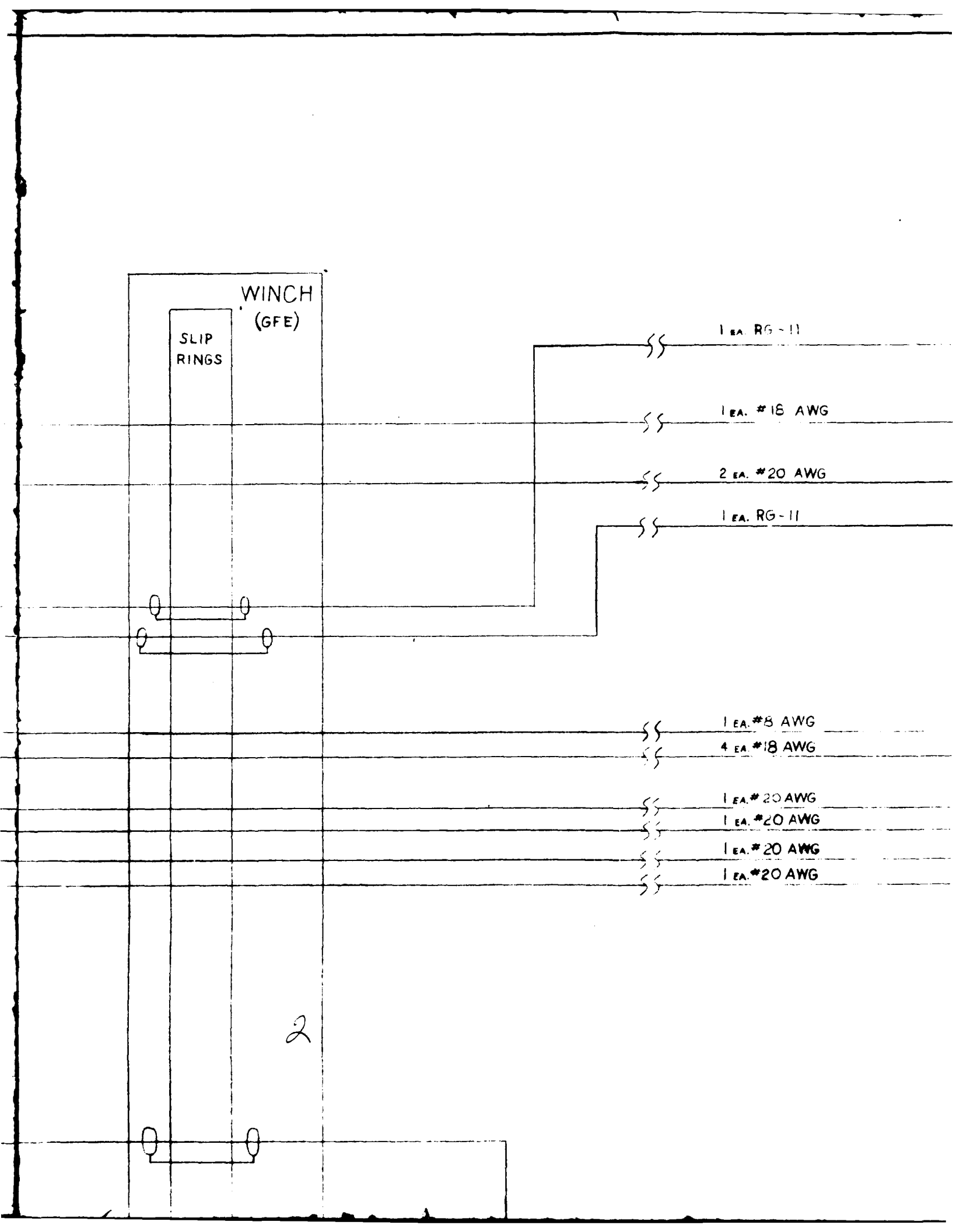
Most of the winches we deliver are based on one of four standard models, ranging in size from small B.T. winches to large hauling winches. Each application, however, requires different line pulls, line rates, capacity, prime movers, etc. As with most products of our line, each design is readily adapted by merely changing gear ratios, hub size, specific motor, etc., with this inherent flexibility resulting in a winch being quickly delivered to specifically meet the customer's requirement at an economical price.

Our product line presently includes plotters, cable systems, and winches as mentioned, and deep sea instrument housings, underwater solenoid valves, underwater switches & potentiometers, two axis ship's log systems, submersible speed sensor, and cable termination systems. Enviromarine is constantly working with potential customers to develop new products as the needs evolve.

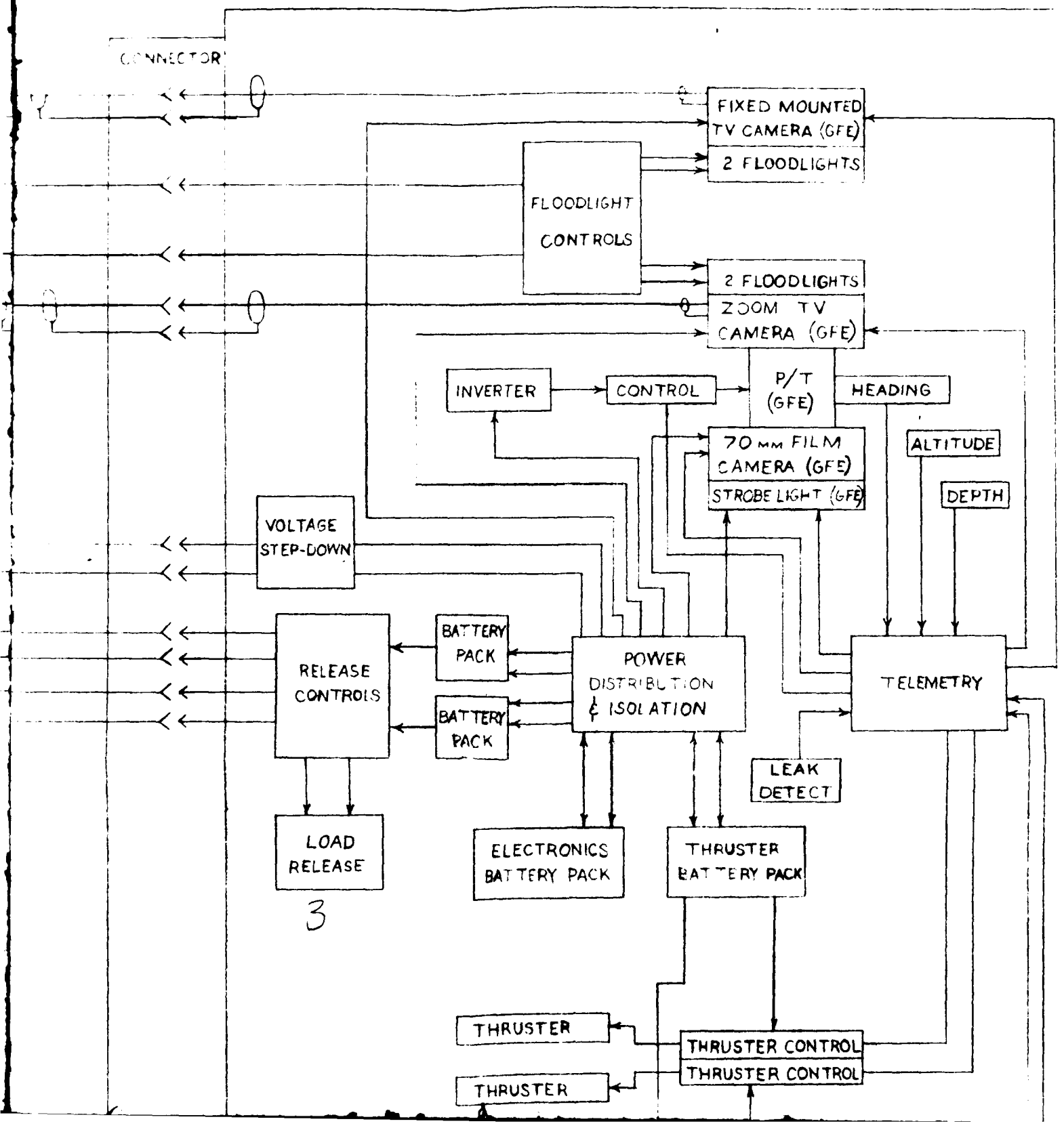
ENVIROMARINE SYSTEMS, INC.

5202 MINNICK ROAD LAUREL, MARYLAND 20810 TELEPHONE (301) 598-8833

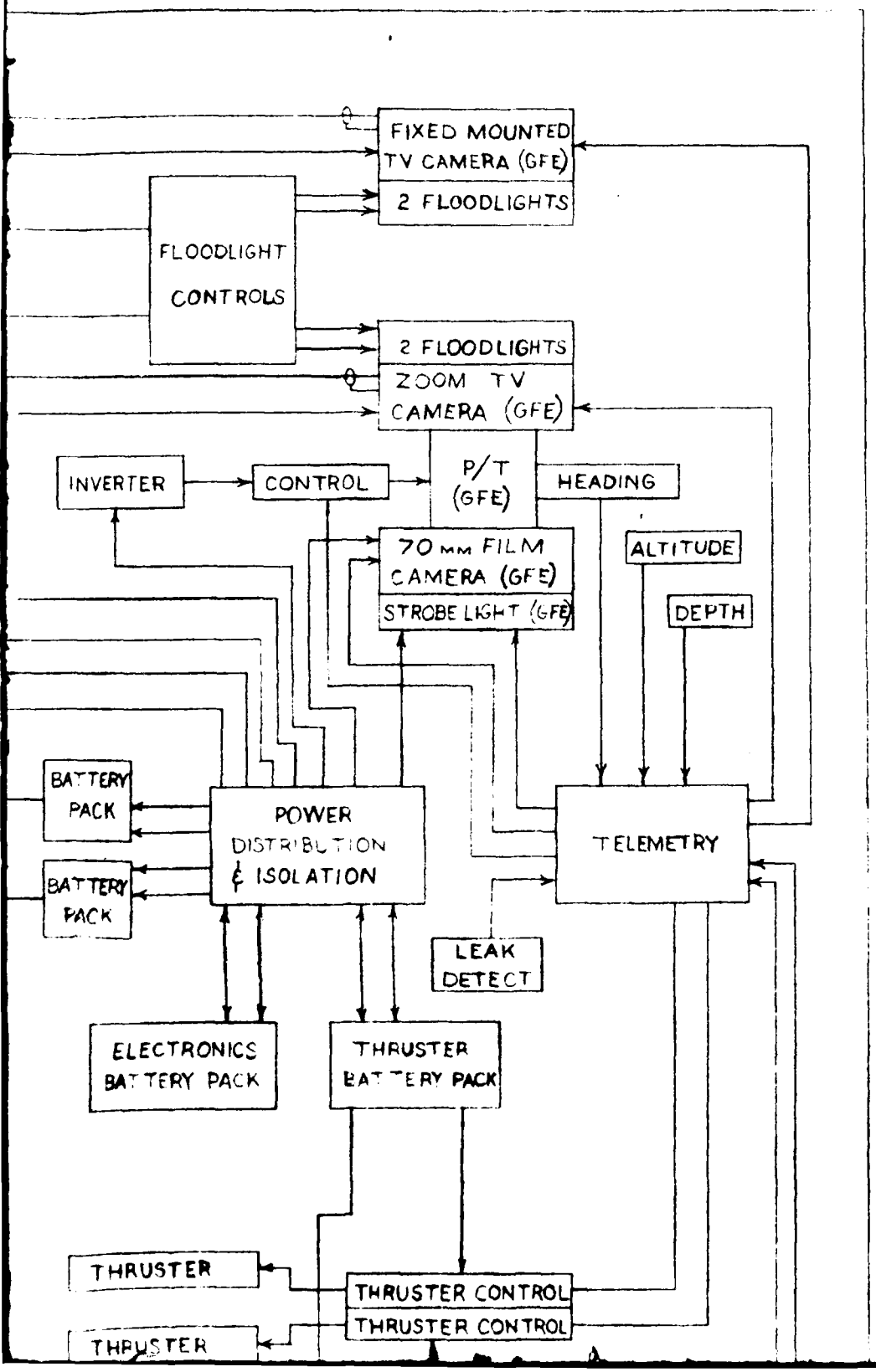

TV MONITOR
TV MONITOR
FLOODLIGHT POWER SUPPLY
DISTRIBUTION AMP
DISTRIBUTION AMP
TIME/DATE
SWITCHING NETWORK
BATTERY CHARGE
VOLTAGE STEP-UP
RF FAGE CONTROL
115 VAC
COMMANDS
SONAR
TELEMETRY
STATUS
MULTIPLEX CIRCUITRY

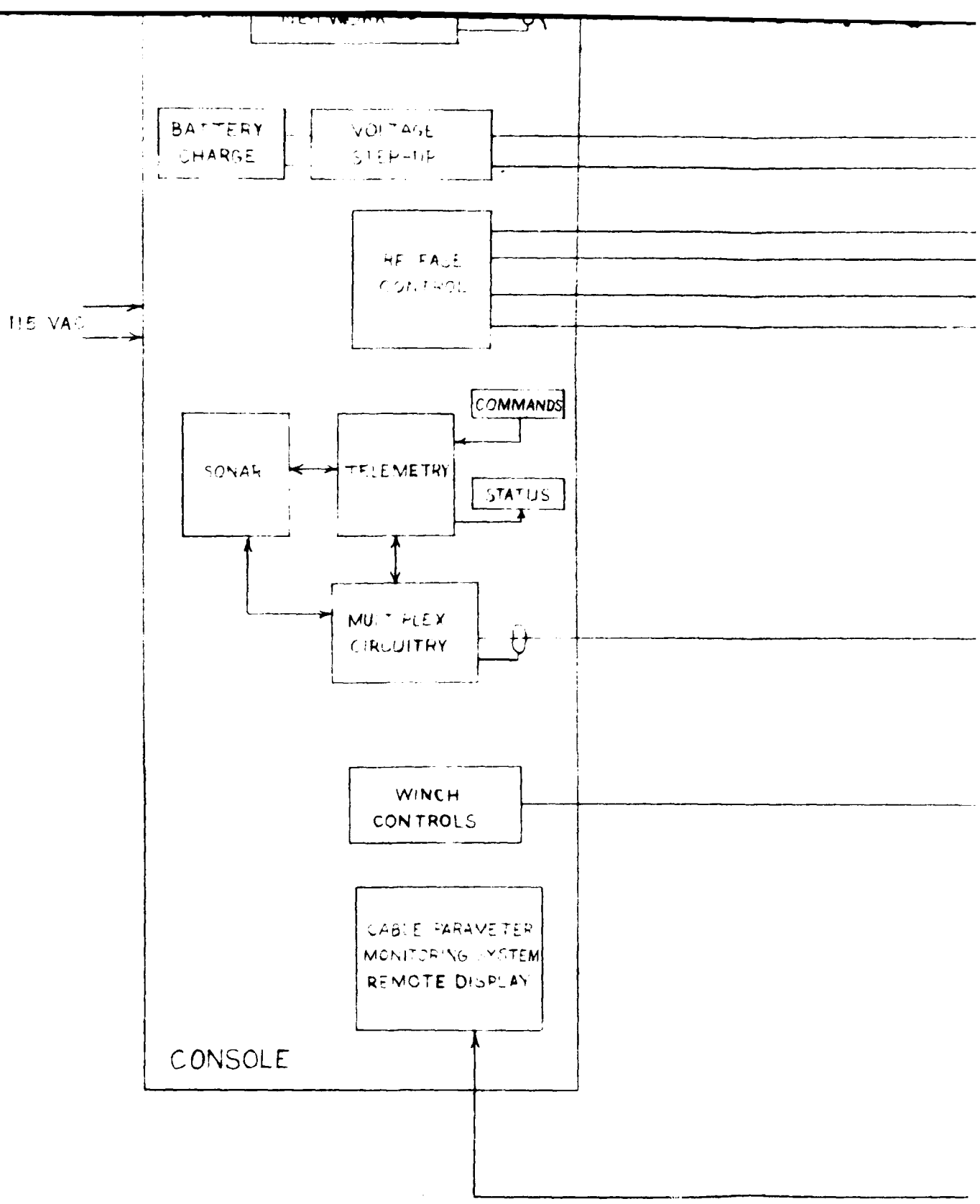

WINCH
(GFE)
SLIP
RINGS
1 EA. RG-11
1 EA. #18 AWG
2 EA. #20 AWG
1 EA. RG-11
1 EA. #8 AWG
4 EA. #18 AWG
1 EA. #20 AWG
1 EA. #20 AWG
1 EA. #20 AWG
1 EA. #20 AWG
2

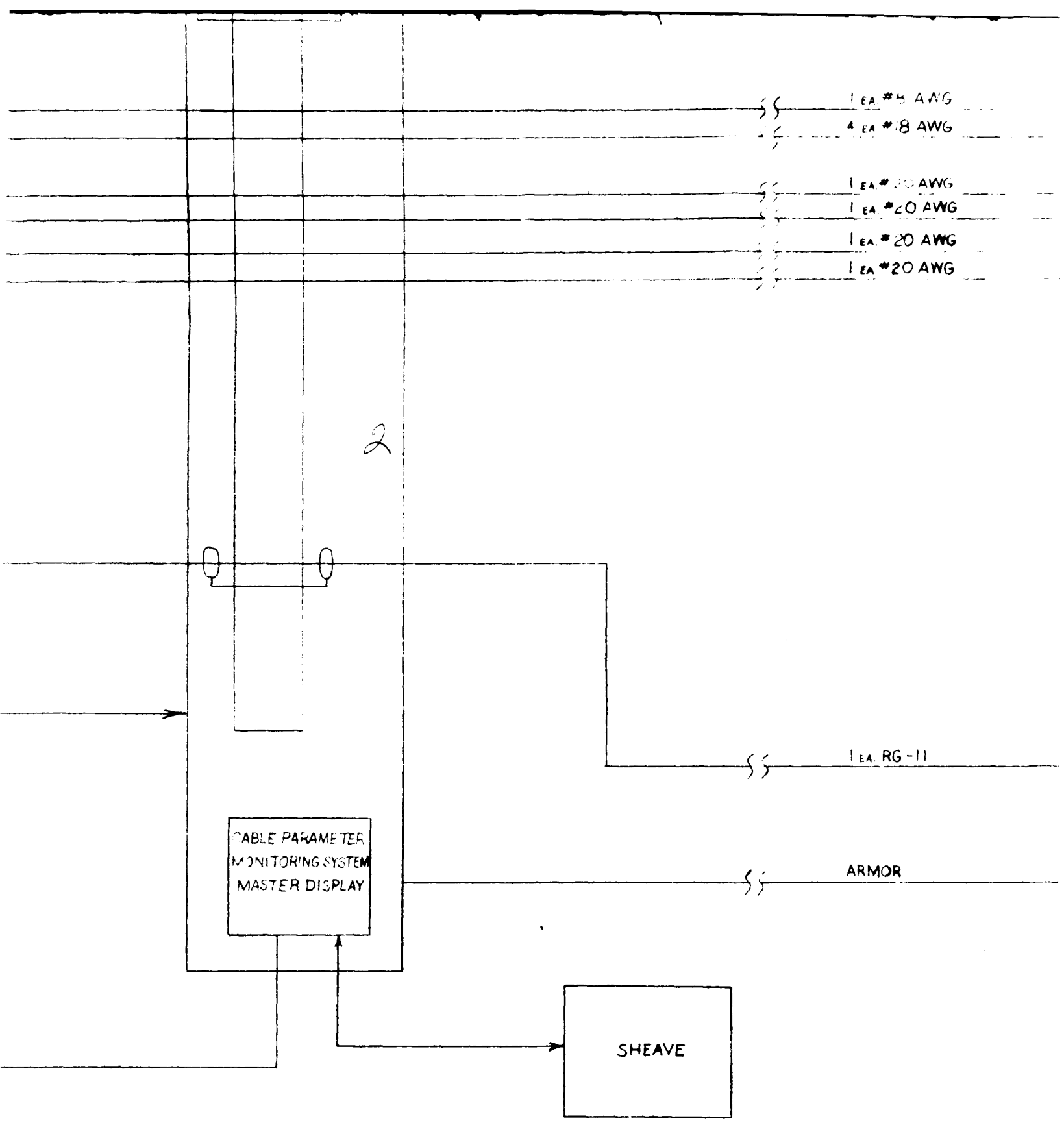
REVISIONS	
SYM	DESCRIPTION

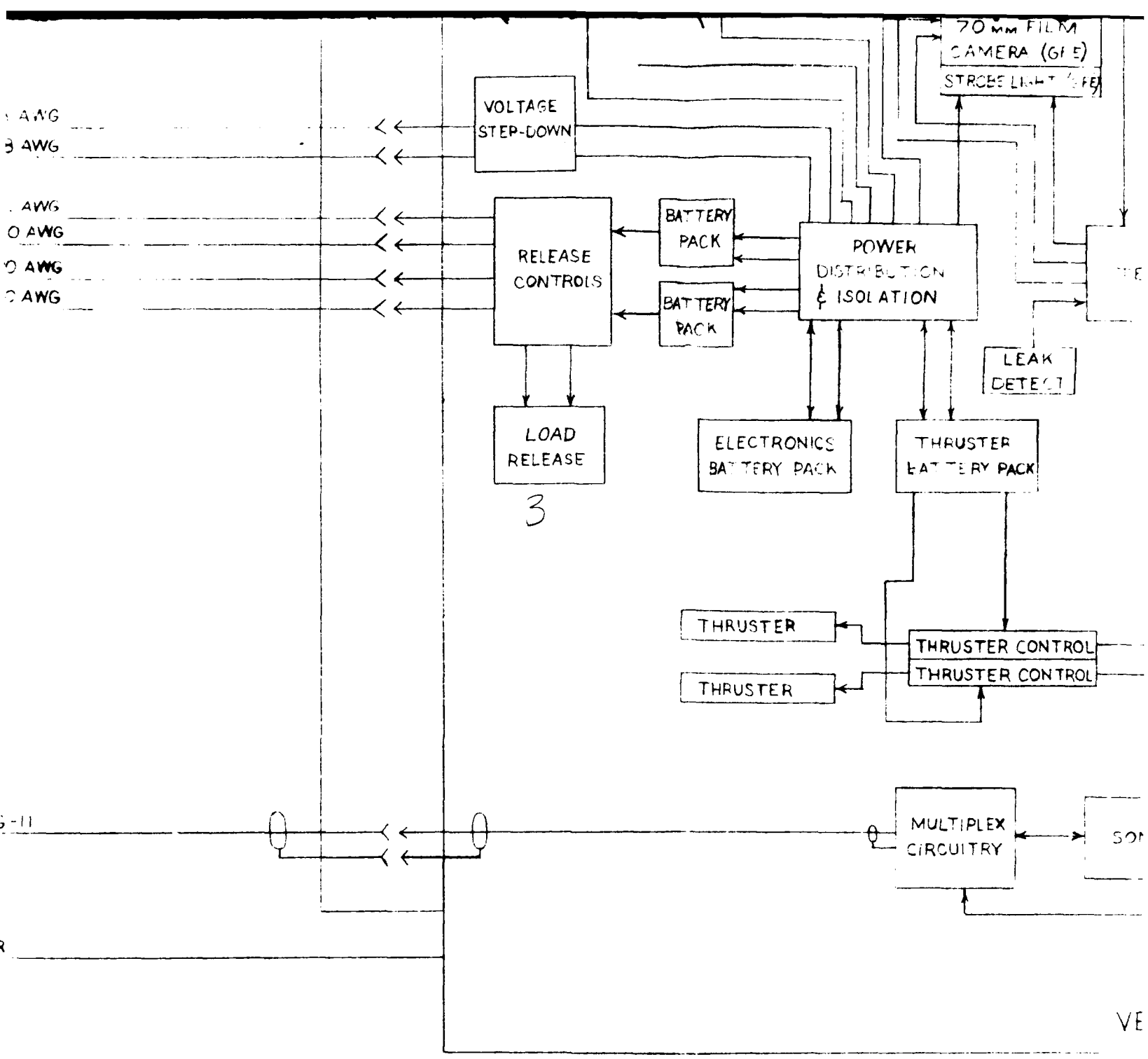


REVISIONS			
SYM	DESCRIPTION	DATE	APPROVE




BATTERY CHARGE
VOLTAGE STEP-UP
RF FAULT CONTROL
115 VAC
COMMANDS
SONAR
TELEMETRY
STATUS
MULTIPLEX CIRCUITRY
WINCH CONTROLS
CABLE PARAMETER MONITORING SYSTEM REMOTE DISPLAY
CONSOLE


1 EA. #5 AWG
4 EA. #18 AWG
1 EA. #20 AWG
1 EA. #20 AWG
1 EA. #20 AWG
1 EA. #20 AWG
2
1 EA. RG-11
CABLE PARAMETER MONITORING SYSTEM MASTER DISPLAY
ARMOR
SHEAVE



3

ELECTRICAL NOTES
UNLESS OTHERWISE DESIGNATED
ALL CAPACITOR VALUES IN MICROFARADS
ALL RESISTOR VALUES IN OHMS
ALL RESISTORS ARE 1/4 WATT 5% TOLERANCE

MECHANICAL NOTES AND TOLERANCES
NOTES
1. ALL DIMS. THIS DWG. IN ____ UNLESS OTHERWISE NOTED
2. SPECIAL TOLERANCES NOTED AS $\frac{XXXX}{FFFF}$
3. TOLERANCES MAY NOT BE ACCUMULATED
4. UNLESS OTHERWISE NOTED REMOVE ALL BURRS BREAK ALL EDGES, REMOVE ALL I.D MARKS & MATLS
5. MACHINED SURFACES TO BE ____ MIN UNLESS OTHERWISE NOTED

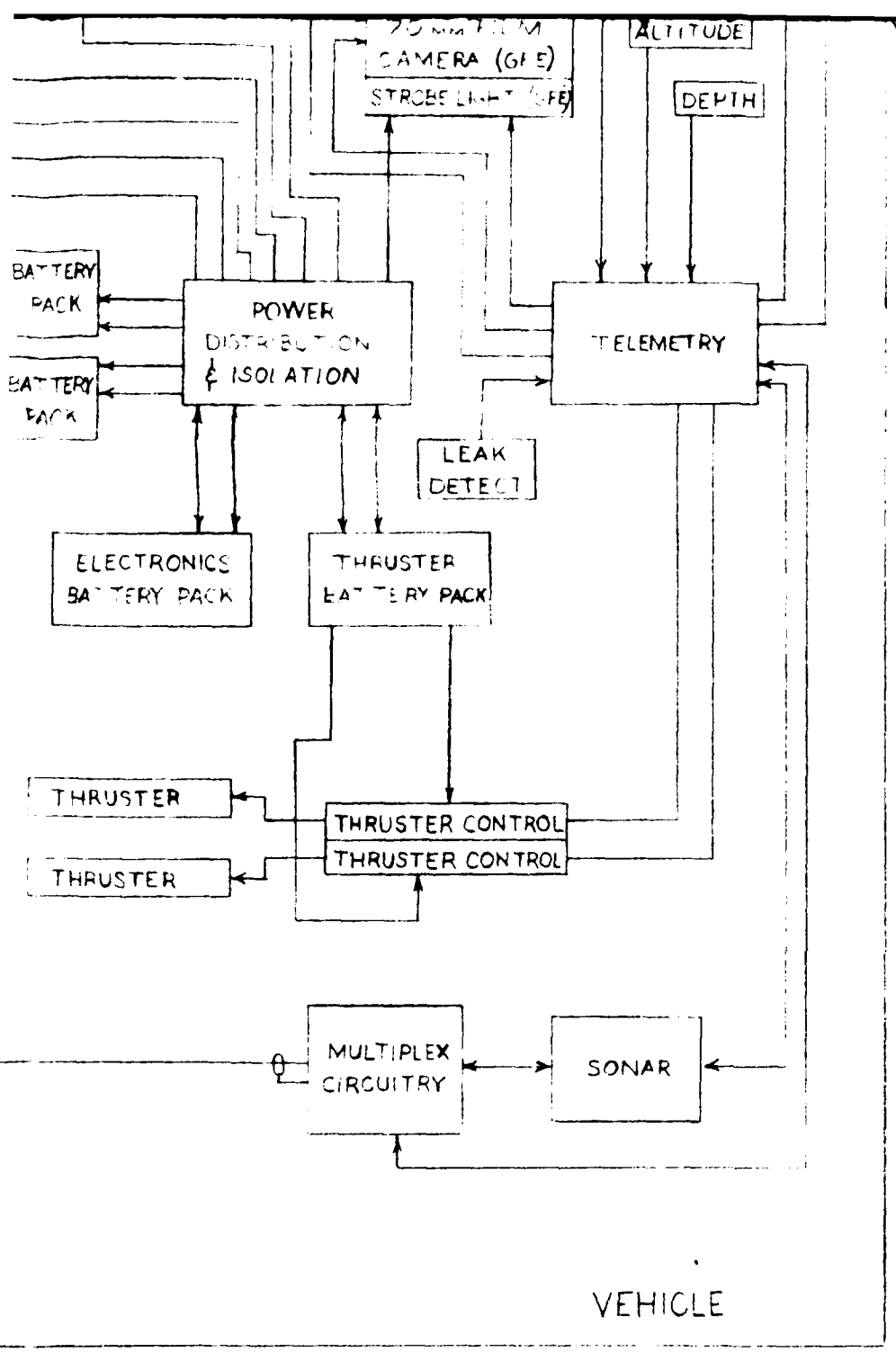
TOLERANCES
X ± ____
XX ± ____
XXX ± ____
ANGLES ± ____

MAT'L	REF. DWGS.
FINISH	
SCALE	

ENVIROM
52
LAUR

DATE 7-5-78	APPROVE BY
NAVFAC UF	
TYPICAL BLOCK DIAGRA	
SHT 1 OF 1	DRAWING

7



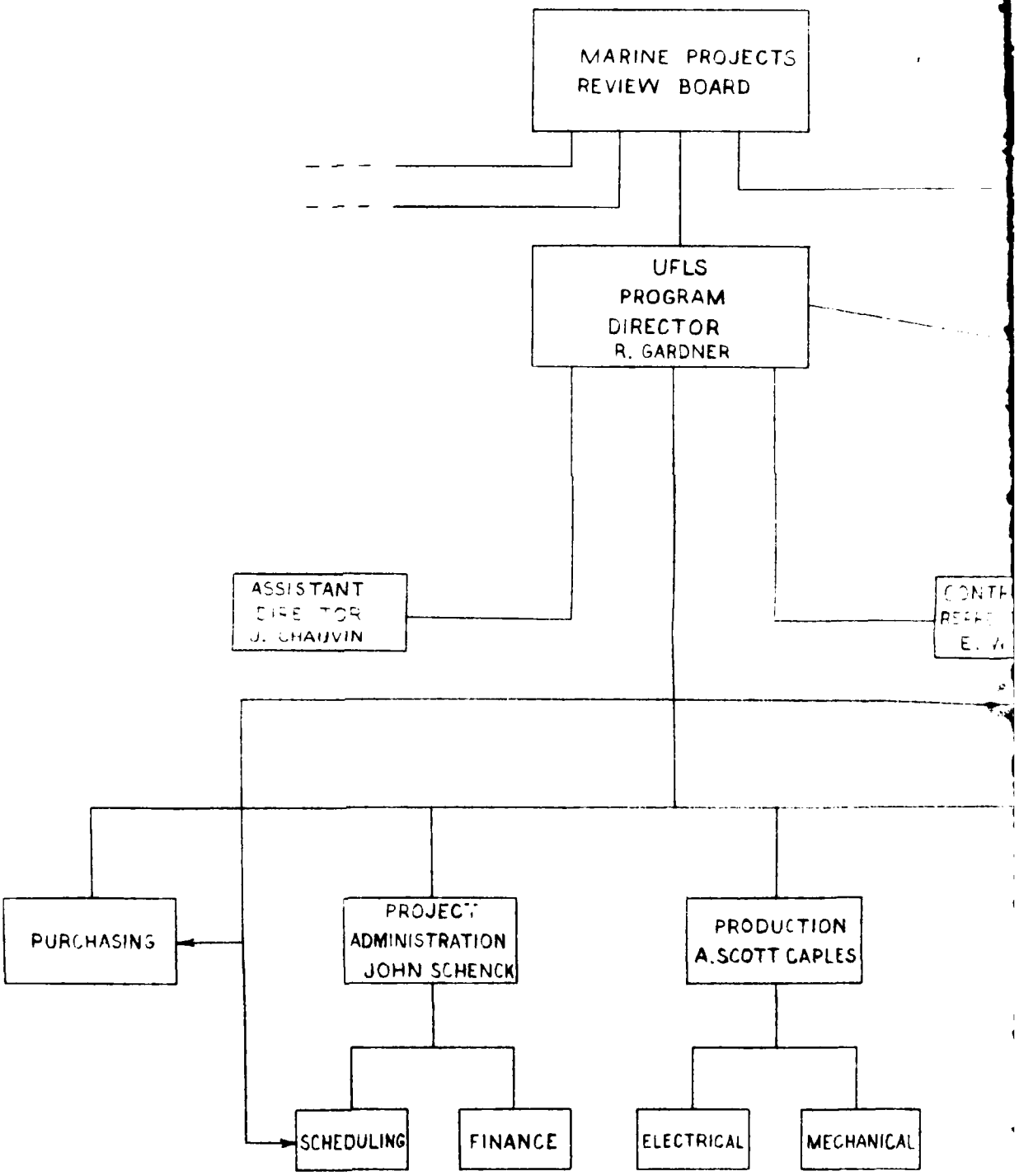
VEHICLE

ENVIROMARINE SYSTEMS, INC. 5202 MINNICK ROAD LAUREL, MARYLAND 20810			
DATE 7-5-78	APPROVED BY		DRAWN BY HW
NAVFAC UFLS			
TYPICAL BLOCK DIAGRAM ELECTRICAL/ELECTRONIC SYSTEM			
SHT 1 OF 1	DRAWING # D-8503-1		REV.

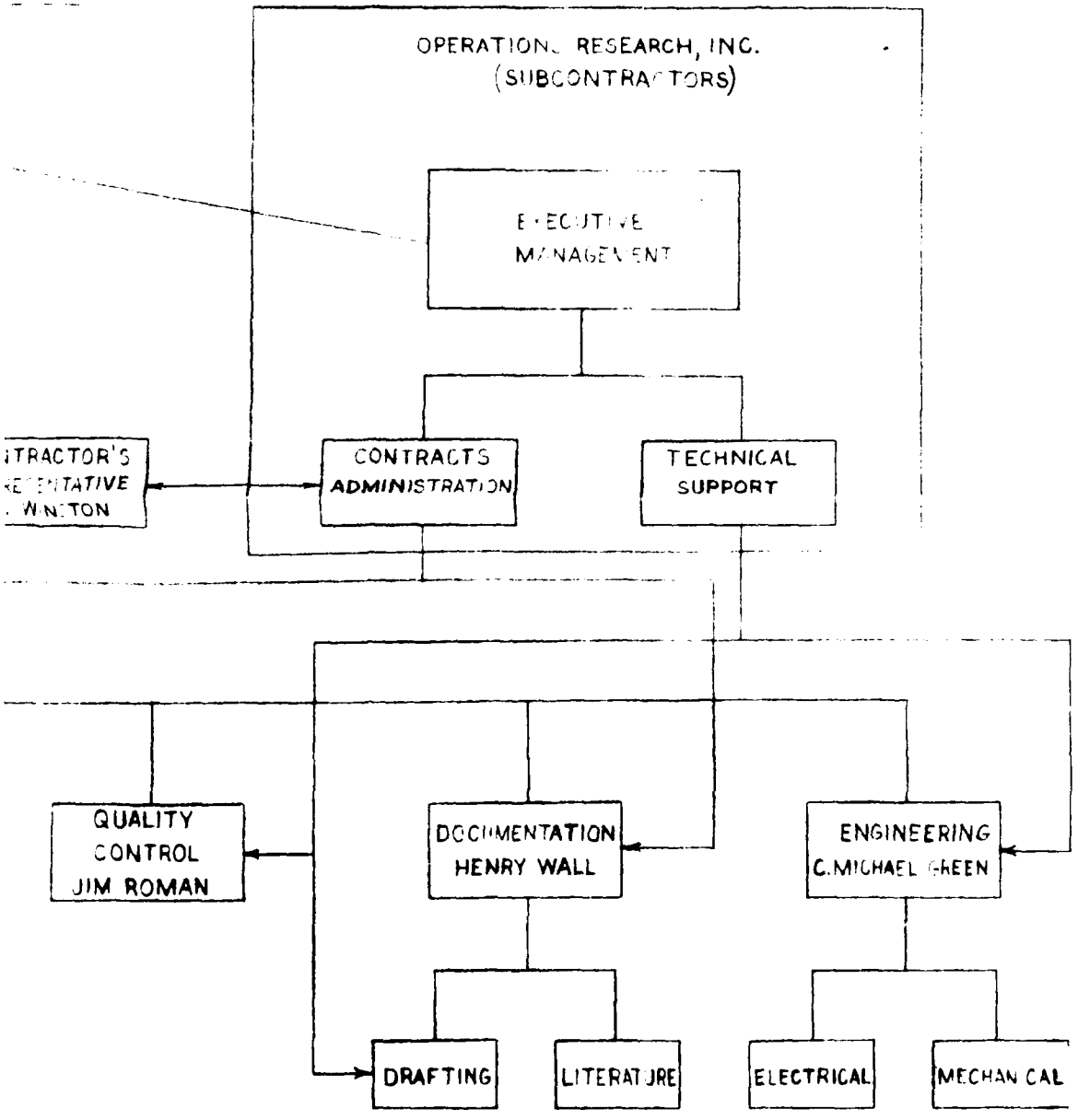
DESIGNATED
VALUES IN MICROFARADS
ALUES IN OHMS
ARE 1/4 WATT 5% TOLERANCE

TOLERANCES
X ±
XX ±
XXX ±
ANGLES ±

REF. DWGS.


MARINE PROJECTS
REVIEW BOARD
UFLS
PROGRAM
DIRECTOR
R. GARDNER
ASSISTANT
J. CHAUVIN
PURCHASING
PROJECT
ADMINISTRATION
JOHN SCHENCK
PRODUCTION
A.SCOTT CAPLES
SCHEDULING
FINANCE
ELECTRICAL
MECHANICAL

REVISIONS			
SYM	DESCRIPTION	DATE	APPROVE

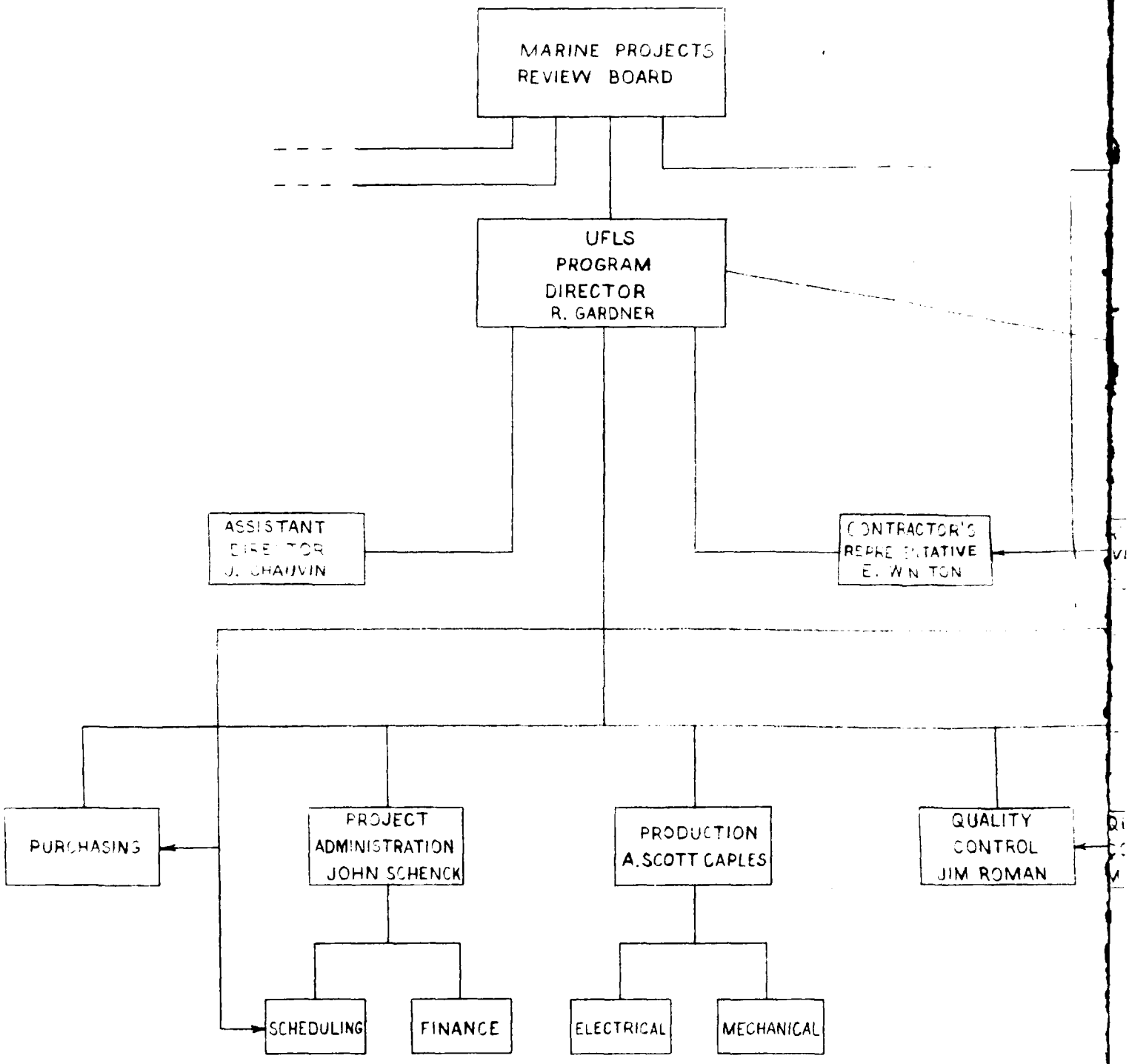


2

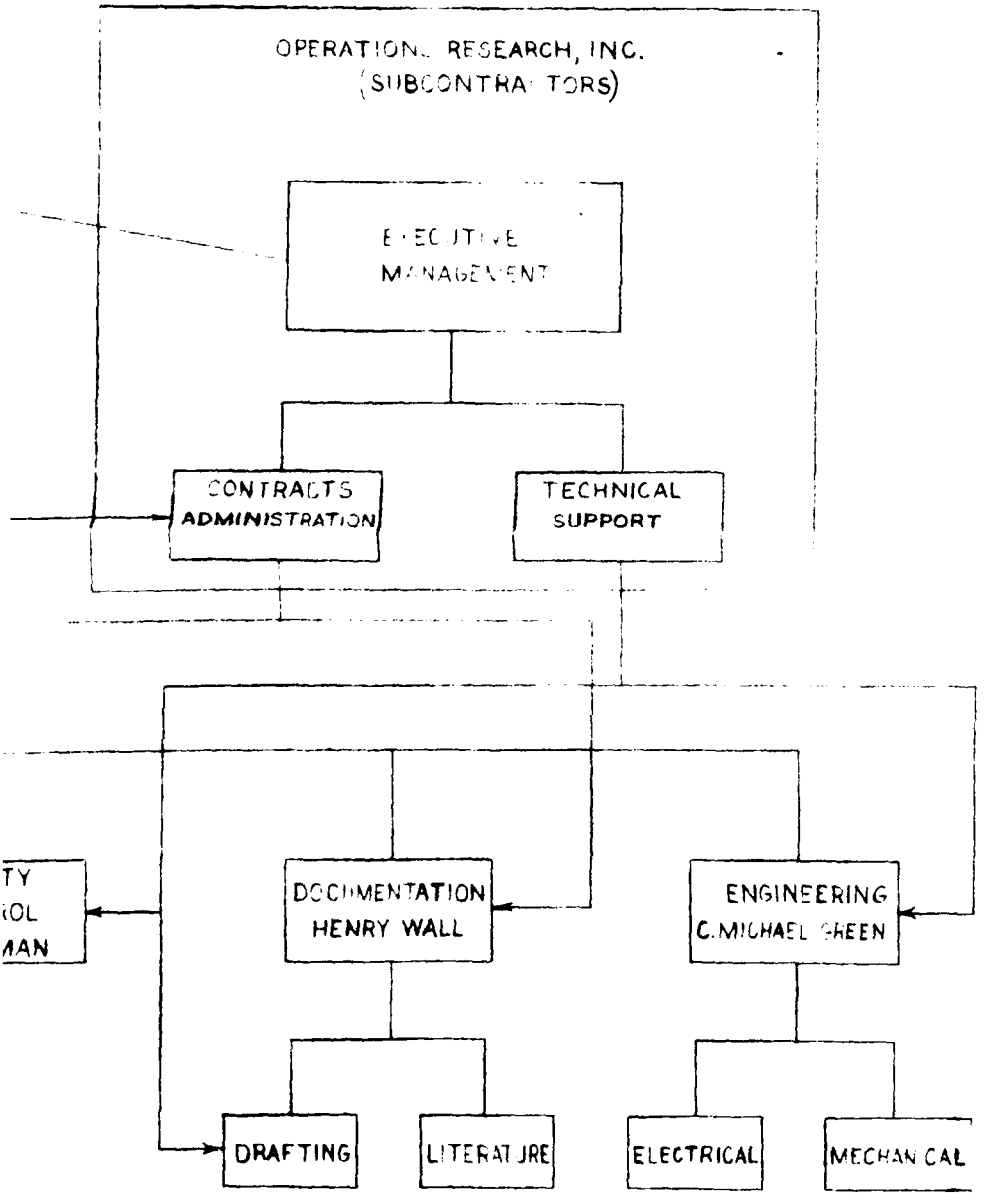
ELECTRICAL NOTES
UNLESS OTHERWISE DESIGNATED
ALL CAPACITOR VALUES IN MICROFARADS
ALL RESISTOR VALUES IN OHMS

MECHANICAL NOTES AND TOLERANCES
TOLERANCES

ENVIRONMENTAL SYSTEMS, INC.
5202 MINNICK ROAD
LAUREL, MARYLAND 20810



ELECTRICAL
UNLESS
MECHANIC
NOTES
MAT'L
FINISH
SCALE



2

ELECTRICAL NOTES UNLESS OTHERWISE DESIGNATED ALL CAPACITOR VALUES IN MICROFARADS ALL RESISTOR VALUES IN OHMS ALL RESISTORS ARE 1/4 WATT 5% TOLERANCE	ENVIROMARINE SYSTEMS, INC. 5202 MINNICK ROAD LAUREL, MARYLAND 20810
MECHANICAL NOTES AND TOLERANCES NOTES 1 ALL DIMS. THIS DWG IN ____ UNLESS OTHERWISE NOTED 2 SPECIAL TOLERANCES NOTED AS "XXXX" 3 TOLERANCES MAY NOT BE ACCUMULATED 4 UNLESS OTHERWISE NOTED REMOVE ALL BURRS BREAK ALL EDGES REMOVE ALL SCRATCHES & MARKS 5 MACHINED SURFACES TO BE ____ MIN UNLESS OTHERWISE NOTED TOLERANCES X ± XX ± XXX ± ANGLES ±	DATE 7-7-78 APPROVED BY R. [illegible] DRAWN BY HW
	NAVFAC UFLS
MAT'L FINISH SCALE REF. DWGS. 4	TYPICAL PROJECT ORGANIZATION CHART
	SHT 1 OF 1 DRAWING # C-8503-1 REV

END

DATE
FILMED

6-86

DTIC